GeoTimes

Professional News Magazine

COORDINATION — COOPERATION · SERVICE · AGI

March 1961

Vol. V, No. 6

Published by the American Geological Institute

Calendar

Cooperation of Society Secretaries in supplying meeting notices for GEOTIMES calendar is requested.

Mar. 7-8, 1961—7th BIENNIAL GEOLOGICAL SYMPOSIUM, sponsored jointly by Univ. of Oklahoma School of Geology and Arkansas Geol. & Conserv. Comm., Univ. of Okla., Norman. Four technical sessions and a dinner meeting; theme, Geology of Arkoma Basin, E. Okla. and W. Ark. Write: Carl A. Moore, School of Geology, Univ. of Okla., Norman.

Mar. 19-25—ASP-ACSM: Annual Meeting, Shoreham Hotel, Washington, D. C.

Mar. 20-24—SEVENTH NUCLEAR CONGRESS, Chicago, Ill.

Mar. 21-30—AMER. CHEM. SOC., 139th Meeting, St. Louis, Mo.

Mar. 24-29, 1961—NAT'L. SCIENCE TEACHERS ASSOC., 9th Ann. convention, Hotel Sherman, Chicago, Ill. Write: NSTA, 1201 16th St., N.W., Washington 6, D. C.

***Mar. 26-31, 1961—SSA & GSA, CORDILLERAN SECT.: joint meeting at San Diego State College, San Diego, Calif. Papers on 27th and 28th, field trips before and after meeting to study geology and geomorphology of the area and geology of NW Baja Calif. and on Scripps Research Vessel. Write: Baylor Brooks, Dept. Geol., San Diego State College, San Diego 15.**

Mar.30-April 1, 1961—FOURTH SYMPOSIUM ON ROCK MECHANICS, at Penn State Univ. Write: Dept. of Mining, Penn. State Univ.

April 7-9, 1961—AIME: Sixth Ann. Mining, Minerals and Petroleum Conf., Anchorage, Alaska. Write: C. F. Herbert, co-chairman, 321 C Street, Anchorage & C. E. Smith, co-chairman, Union Oil of Cal., 2805 Denali St., Anchorage.

CANCELLED

April 9-11, 1961—SEGp: Ann. Midwestern Meeting, Oklahoma City.

April 10-May 21, 1961—SEVENTH COMMONWEALTH MINING & METALL. CONG., Johannesburg, So. Africa.

***April 13-15, 1961—GSA: SE SECTION Ann. meeting, Andrew Johnson Hotel, Knoxville, Tenn. Sponsored by Univ. of Tenn. and Tenn. Division of Geology. Papers—2 days, field trips—1 day. Write: Harry J. Klepser, Dept. of Geology, Univ. of Tenn., Knoxville.**

April 17-19—CIM: Annual General Meeting, Chateau Frontenac, Quebec City, Quebec.

***April 18-19, 1961—MUSKEG RESEARCH CONF., 7th Ann. Meeting, McMaster Univ., Hamilton, Ont. Field trip planned. Write: I. C. McFarlane, c/o Div. of Bldg. Research, Nat. Research Council, Ottawa 2, Canada.**

April 18-21, 1961—AGU: Ann. meeting, Nat. Acad. Sci., Washington, D. C.

April 20-21, 1961—AIME: Soc. of Petrol. Eng., East Texas-Lou.-Ark., gas technology symposium, Tyler, Texas.

April 20-21, 1961—AASG: Ann. meeting, Moscow, Idaho.

April 20-22, 1961—OHIO ACAD. OF SCIENCE, 70th Ann. Meeting, Univ. of Cincinnati.

April 23-27—ACerS: 63rd Annual Meeting, Royal York Hotel, Toronto, Ontario.

April 24-25, 1961—AIME: Nevada Sect., South-West Mineral Industry Conf., in conjunction with Industrial Metals, Stardust Hotel, Las Vegas, Nev. Write: L. J. Hartzell, P. O. Box 2008, Henderson, Nevada.

***April 24-27, 1961—AAPG-SEPM: 46th Ann. Meeting. Jointly with Rocky Mountain Sect., A.A.P.G., Hilton Hotel, Denver, Colo. Field trips before and after meetings to study all phases of Colorado geology. Write: Laurence Brundall, 305 E & C Bldg., Denver 2.**

April 27-29, 1961—6th ANN. INST. OF LAKE SUPERIOR GEOLOGY, Port Arthur, Ont., Canada. Write: E. R. Mead, 213 Park Street, Port Arthur.

April 28, 1961—W. VA. ACAD. OF SCIENCE, Geol. and Mining Sect., Bethany College, Bethany, W. Va.

May 4-5, 1961—AIME: Soc. of Petrol. Eng., oil recovery conf., Midland, Texas.

***May 11-13, 1961—GSA: Rocky Mountain Sect., meeting at Laramie, Wyo., with 1-day field trip to study Precambrian and sedimentary rocks and geomorphology in the Laramie Basin. Write: W. R. Keefer, Box 3007, Univ. Sta., Laramie.**

***May 12-14, 1961—AIME: Central New Mexico Sect., Sixth Ann. Uranium Symposium, Grants, N.M. Field trip to neighboring mines and mills.**

May 25-26—AIME: Joint Meeting Rocky Mountain Petroleum Sects., Salt Lake City, Utah.

June-July, 1961—WORLD METEOROLOGICAL ORGANIZATION, Regional Assoc. III (South America), Session, 3rd, Rio de Janeiro, Brazil. Campagne Rigot, Av. de la Paix, Geneva, Switzerland.

July 17-22—INTERNAT. CONF. ON SOIL MECHANICS & FOUNDATION ENGINEERING, 5th, Paris, France. M. Buisson, Gen. Sec'y., Assoc. Francaise de Mech. des Sols et des Fondations, 31, rue Henri Rochefort, Paris 17e, France.

July 30-Aug. 4, 1961—AMER. CRYSTALLOGRAPHIC ASSOC., Boulder, Colo.

Aug. 21-31, 1961—U.N. CONF. ON NEW SOURCES OF ENERGY, (Solar Energy, Wind Power and Geothermic Energy), Rome. Write: U.N., New York.

Aug. 21-Sept. 6 — PACIFIC SCIENCE CONGRESS, 10th, Honolulu, Hawaii. Pacific Science Assoc. Secretary General, 10th Pacif. Sci. Cong., Bishop Museum, Honolulu 7, Hawaii.

Aug. 21-Sept. 6—SPECIAL COMMITTEE ON OCEANIC RESEARCH, 5th Meeting, Honolulu. Dr. Günther Böhnecke, Secy., Bernhard-Nochstr. 78, Hamburg 4, Germany.

Summer—INTERNAT. COUNCIL OF SCIENTIFIC UNIONS, 9th General Assembly, London, Eng. National Academy of Sciences-National Research Council, Washington 25, D. C.

Sept. 3-8, 1961—AMER. CHEM. SOC., 140th meeting, Chicago, Ill.

Sept. 18-23—III INTERNAT. CONGRESS OF SPELEOLOGY, Vienna, with excursions before and after the meetings. Write: Generalsekretariat des 3. Internationalen Kongresses für Speläologie, Verband österreichischer Höhlenforscher, Wien II, Obere Donaustrasse 99/7/3.

Oct. 8-11, 1961—AIME: Soc. of Petr. Engrs., Fall meeting, Dallas, Texas.

***Oct. 14-18, 1961—NATIONAL CLAY CONF., Univ. of Texas, Austin. Field trip Oct. 14 to bentonite localities of Texas Gulf Coast and vermiculite field trip Oct. 15. Write: E. Joseph Weiss re program or papers and Stephen E. Clabaugh re field trips, both at Univ. of Texas.**

Oct. 18-20, 1961—OPTICAL SOC. OF AMER., Ann. Meeting, Los Angeles, Calif.

Oct. 18-21, 1961—AAPG: Mid-Cont. Regional meeting, Amarillo, Texas.

Oct. 25-27, 1961—GULF COAST ASSOC. OF GEOL. SOC'S., meeting, San Antonio, Tex.

*Nov. 1-3, 1961—SOUTHWESTERN FED. OF GEOL. SOC'S., Ann. Meeting. El Paso, Tex. Trip into northern Chihuahua, Mex. to study geol. of the area. Write: Texas Western Coll., Geol. Dept., El Paso.

Nov. 2-3, 1961—AIME: Soc. of Petr. Engrs., 32nd Ann. California regional meeting, Los Angeles, Calif.

*Nov. 2-4. 1961—GSA: Ann. Meeting, Cincinnati, Ohio. Nine trips through area around Cincinnati to study Paleozoic stratig. and struct.; Write: Ralph J. Bernhagen, Ohio Geol. Surv., Ohio State Univ., Columbus 10. re trips. Guidebooks.

Nov. 5-9. 1961—SEGp: 31st Ann. Internat. Meeting, Denver, Colo.

Nov. 9-10, 1961—AAPG: Pacific Coast Sect. Regional Meeting, Los Angeles, Calif. Cancelled—in deference to support being given to the national AAPG meeting in San Francisco, Mar. 26-29, 1962.

Nov. 13-15, 1961—A.P.I.: Ann. Meeting, Chicago.

Dec. 26-31, 1961—AAAS: Ann. Meeting, Denver, Colorado.

*December—TEXAS ACAD. OF SCI., Ann. Meeting. Trip through Gulf Coastal area to study recent sedimentation. Write: W. R. Muehlberger, Dept. Geol., Univ. Texas, Austin 12.

1961 SCHEDULE OF FIELD TRIPS

For additional field trips held in conjunction with meetings, see those items marked with an asterisk under meeting calendar.

Mar. 24-25—SHREVEPORT GEOL. SOC., trip to study Upper and Lower Cretaceous outcrops and Paleozoic contacts in SW Ark. and SE Okla. Write: J. D. Aimer, Box 1092, Shreveport.

April 7-8—GEOL. SOC. OF KENTUCKY, Ann. Spring Field Conf., Middlesboro, Ky., to study "Geologic features of Cumberland Gap area, Ky., Tenn., and Va." Write: T. J. Crawford, Ky. Geol. Surv., Univ. of Ky., Lexington.

April 14-15—TULSA GEOL. SOC., trip to Arkoma Basin, E. Cent. Okla. and W. Ark. to study Miss., Penn. and petrol. geol. of basin. Write: Hubert H. Hall, 1133 N. Lewis Ave., Tulsa, Okla. Guidebook.

April 15—ILLINOIS STATE GEOL. SURV., trip to Mississippian strata and glaciation evidences of the Sparta region, Randolph County, Ill.

April 19-23—SIGMA GAMMA EPSILON, Kansas State Univ., trip E. Kans. to Illinois and return to study geology along routing. Write: Arthur Booth, Dept. Geol., KSU, Manhattan, Kans. Mimeo Guidebook.

April 29-30—GEOL. SOC. OF SACRAMENTO, trip to Sacramento Valley on E. side to study Marysville Butte and Feather R. Canyon, etc. Write: Lowell Garrison, Box 4195, Sacramento 21. Guidebook.

May 5-7—GEOLOGIC FIELD CONF., 10th Indiana on Stratigraphy of the Silurian rocks of Northern Indiana, Indiana Geological Survey joint with Dept. of Geology, Indiana University. Hdqtrs. Spencer Hotel, Marion, Ind. Write: M. E. Biggs, Geol. Survey, Bloomington, Ind.

May 5-7—SOUTHWESTERN ASSOC. OF STUDENT SOC'S. 2nd ann. field trip to "Arbuckle Mountains and Criner Hills of Oklahoma." Chairman: Prof. J. Loyd Watkins, % Midwestern University, Wichita Falls, Tex. Guidebook.

May 6—ILLINOIS STATE GEOL. SURV., trip to study Mississippian formations and to collect geodes and fossils in the Hamilton region, Hancock County, Ill.

(Continued on page 52)

This Month in GEOTIMES

Professional News Magazine

Published by THE AMERICAN GEOLOGICAL INSTITUTE

Robert C. Stephenson, EDITOR

Kathryn Lohman, CIRCULATION MANAGER

VOL. V, No. 6 — MARCH, 1961

GEOTIMES is published eight times a year, January-February, March, April, May-June, July-August, September, October, November-December, by the American Geological Institute at Williams and Heintz Lithograph Division, Washington, D. C. Address all correspondence to 2101 Constitution Ave., N.W., Washington 25, D. C.

Subscriptions: GEOTIMES is distributed to members of supporting Member Societies as a part of their society membership. Non-member rates—U.S.A. and Possessions, Canada and Mexico, $2.00 per year; elsewhere, $2.50 per year. Single copy .35¢. Second class postage paid at Washington, D. C.

An Editorial Dispensation

The Editor has graciously allowed me to use this page for an important matter, and one which very logically—albeit purely coincidentally in this case—follows the editorial message in the preceding issue.

The Member Societies and the members of our Member Societies should know that some very important and most effective programs of the Institute are carried on by committees and that the dedicated and hard-working chairmen of these committees are especially deserving of commendation.

We have just recently completed the appointments of all committee chairmen for the calendar year. Many of these are reappointments, in order that we may benefit from experience of the veterans; some are new, in order that we may benefit from "new blood". In all cases, the Institute's membership should know who these self-sacrificing scientists are. This is important, in part that we may know whom we should honor; in part that we may know to whom we can most appropriately direct ideas, comments and constructive critcism that may come within any of these several special interest fields.

Here, then, is the 1961 "Honor's List":

Boy Scout	*Chalmer L. Cooper*
Data Sheet	*Richard M. Foose*
Education	*Chalmer J. Roy*
International Field Institute	*Paul R. Shaffer*
Finance	*Michel T. Halbouty*
Government Relations	*Ottmar F. Kotick*
Mission 66	*James L. Dyson*
Professional Standards	*B. Warren Beebe*
Teaching Resources Development	*Robert L. Heller*
Translations	*Herbert E. Hawkes*
Visual Education	*William R. Muehlberger*

In addition, we should here acknowledge our indebtedness to outgoing chairmen Earl Ingerson of the Translation Committee, B. W. Beebe of the Reorganization Committee, and M. Hall Taylor of the Visual Education Committee. With the publication of the Supplement to the AGI Glossary, the chairman of the Glossary Review Committee, J. Marvin Weller, has asked to be relieved of further responsibilities, although revisions and additions to the Glossary are contemplated in the future. *Ian Campbell*

OUR COVER

Geological dredge being hoisted aboard the U. S. Coast and Geodetic Survey ship Explorer. For story see page 8.

The AMERICAN GEOLOGICAL INSTITUTE is a non-profit professional service organization established and managed by the scientific societies in the fields of geology and geophysics in cooperation with the National Academy of Sciences-National Research Council. It is the instrument of the profession serving and advancing the welfare of the geoscientist in matters relating to education, professional responsibilities and government relations. It is an active member of the Scientific Manpower Commission. It also functions in the stimulation of public education and awareness of the earth sciences, through career literature, the scouting program and other channels of communication.

GEOTIMES is the news magazine of the geological sciences. It reports on current events in the earth sciences, public education and public relations efforts throughout the profession, as well as appropriate legislative and governmental issues. It announces scholarships, fellowships, publications and new developments. It provides a forum for discussion of timely professional problems, and affords a common bond between the many specialized groups within the earth sciences.

Geologic Aspect of Coast and Geodetic Survey Operations

by Rear Admiral H. Arnold Karo
Director, U. S. Coast and Geodetic Survey

The Coast and Geodetic Survey has had a general reorganization to extend and exploit the scientific and technological potential of the Survey. The organizational structure of this old-line Bureau of the United States Department of Commerce has been strengthened to meet the needs of this new and revolutionary age of science and technology.

The enlarged scope of Bureau operations intensifies phases of the work concerned with the field of geology. Especially pertinent in geological studies are earth measurements obtained in geodetic, hydrographic, and topographic operations; changes occurring in and beneath the earth's crust are indicated by geomagnetic and seismological observations; and the interrelation between land sea level changes is determined by tidal observations. Oceanography is now receiving new recognition and encouragement to open up a vast new potential for a dramatic increase in scientific knowledge.

Until recent years geological exploration of the earth's mantle practically stopped at the continental and insular margins. Information on deep-sea submarine topography has generally been incomplete or unreliable. Modern hydrographic surveying and oceanography is removing this veil from much of the undersea area. The geologist is now being provided with an abundance of new physiographic detail. In addition to making available contoured bathymetry, the hydrographer and oceanographer now employ an impressive array of modern electronic instrumentation and techniques which provide increasingly more detail of submarine relief.

The modern advance in surveying techniques parallels other progress which is rapid and ever-broadening in twentieth century civilization. National interests in ports, rivers, harbors, beaches, and other natural marine resources on the coasts have become of paramount importance. The geologist is well aware of the services needed in the exploration and development of coastal areas.

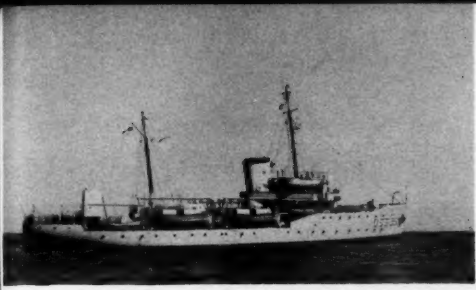
Crater Lake Survey

The significance of hydrographic surveys to geological knowledge is not confined to oceans and large lakes. Detailed hydrographic surveys of small lakes often reveal information of geological import, giving rise to new theories or explanations, or confirming or disallowing old ones. In this category is a detailed survey of Crater Lake, Oregon, conducted in 1959 by a Coast and Geodetic Survey field party.

Through a joint arrangement between the National Park Service and the Coast and Geodetic Survey, the six-mile wide, mountain-perched lake was probed thoroughly during the survey. With the aid of a launch provided by the National Park Service, and using Coast and Geodetic Survey electronic sounding equipment, the party made the first detailed and accurate record of the depths and the bottom configuration of the lake.

This survey provided part of the accurate inventory basic to sound scientific deductions concerning the geologic aspects of the lake region. Without such an inventory theories about the geological history of the lake were naturally subject to uncertainties usually apparent when all available information has not been gathered. With the new data resulting from the survey, knowledge of the exact depth of any part of the lake is assured and any supposition that the lake be of extreme depth in places is ruled out. Geologists can now study the bottom contours of the lake with assurance not heretofore enjoyed.

Accurate hydrographic data are important to any interpretation of this lake because of the lake's interesting geological setting. It occupies the caldera of an old volcanic mountain in the Cascade Range. It is not a "crater" lake, for such lakes occupy only the small depression at the



U. S. Coast and Geodetic Survey ship EXPLORER.

top of an extinct volcano. The top of this old volcanic mountain, called Mount Mazuma, vanished long ago in the geologic past, leaving only the stump of the mountain. The lake actually occupies the caldera, the bowels of the old volcano, now rimmed by the remaining "stump."

Maximum depths revealed by the survey include one of 1935 feet below lake level, which is approximately 6,177 feet above sea level, definitly establishing the lake as the deepest in the United States and second deepest in North America. Only Great Slave Lake in Canada is deeper, with a maximum depth of 2015 feet. The Crater Lake survey definitely established the existence of other parasitic volcanic cones, like the one comprising Wizard Island at the western end of the lake. Several submerged cones were revealed southeast and east of Wizard Island, and a large submerged one was located off the north shore, two miles south of Punica Point.

Limited surveys of parts of the lake had been made before, but they were incomplete and inaccurate. About four decades after this scenic lake's discovery in 1853, interested persons began to take soundings by lead line. This was continued even after the area became a National Park in 1902. Finally in 1957 the National Park Service compiled a map showing this cumulative effort. Now, this modern survey by the Coast and Geodetic Survey in 1959, with electronic equipment and precision methods, has thus produced the first complete and accurate chart of the lake.

The new chart to be published in the near future will provide geologists with a substantially accurate inventory needed for definitive interpretation of the geology of the region. The parasitic cones verify considerable volcanic activity after the disappearance of the original mountain, and submerged areas around Phantom Ship seem to indicate volcanic cones prior to the formation of old Mount Mazuma.

Other important factors will undoubtedly be indicated to geologists by interpretation of data revealed in this survey. For instance, the survey revealed no outlets to the lake, indicating that seepage and evap-

SCUBA divers go over the side of the C & G ship Gilbert.

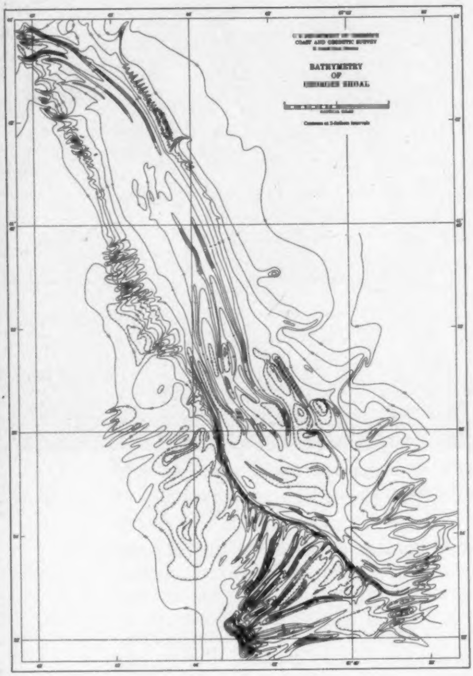
oration must keep the lake level balanced against precipitation. Still other revelations might be added to further substantiate the contention that hydrographic surveys of this sort are significant to the accumulation of geological knowledge, both directly and indirectly.

Special Surveys of Geologic Significance

Geological studies of the continental margins are especially dependent upon the hydrographic surveys which provide bathymetry and bottom characteristics of the submarine topography and which periodically furnish information on the movement and deposition of sediments. Extending beyond the immediate coastal areas, across the continental terrace, and into ocean basins, the hydrographic survey has in more recent years provided an abundance of physiographic data which is eagerly awaited by students of geological history.

These data include delineation of various types of continental terraces and their superficial features; extensive deep trenches which front many topographic highs; huge fault ridges and scarps as well as deep-sea channels which mar the ocean floor in several areas; and high mountain ranges and volcanic cones which lie in great numbers deep beneath the surface of the sea. By unmasking the submarine topography the hydrographic survey is making a necessary and important contribution to geological knowledge.

The relationship between land and sea is anything but static. In southeast Alaska,



Bathymetry of Georges Shoal off the New England Coast by the U. S. Coast & Geodetic Survey.

for example, the tide gage records of the Coast and Geodetic Survey have provided a clue to relatively recent uplift of the marginal land mass. Engineers running levels have reported to the Survey that in places the land appears to be higher than had been reported. At Haines, Alaska, this apparent rise is nearly five feet. Possibly this is related to the release of pressure following the retreat of the glaciers. Such isostatic rebound is well documented in Finoscandia and the Great Lakes Region. More probably it is related to the active forces of orogeny, to the tectonic activity for which this area has a long record in historical time. In order to find out the extent and actual magnitude of this uplift, the Survey for the past two field seasons has had a ship in the area running 60-day series of tide observations at every spot where the Survey has had tide gages in the past. Level lines have been run to the bench marks related to these observational sites, and an office analysis of these data is now under way.

From time to time during routine bathymetric surveys, underwater features are discovered which alert the geological curiosity of the Survey scientists so that additional studies are made to try to unravel the mystery the feature has presented. One such feature was the superb swarm of sand ridges found in the early 1930's on Georges Shoal off Cape Cod, Massachusetts. Subsequent surveys in the late 1950's using Raydist control and precise echo sounders showed that these ridges apparently had migrated to the west. Coast and Geodetic Survey diving oceanographers went out to investigate under the direction of Dr. Harris B. Stewart, Jr., chief oceanographer of the Survey. Armed with underwater motion picture cameras, sediment sampling devices, and fluorescein dye, Dr. Stewart and his associates observed and photographed the movement of water and sediment at the sediment-water interface and sampled the sediments on the crests and in the troughs of the ridges.

Since the Coast Survey has no sediment analyses facilities, it co-operates with other agencies and private institutions in the field of sedimentation. These Georges Shoal samples, for example, were taken in triplicate, and a set has been studied by the Scripps Institution of Oceanography, and the other two sets are at the U. S. Geological Survey and at Johns Hopkins University where additional studies will be made.

The underwater movies have been shown to geologists in many cities who are interested in sediment transportation. The photography reveals that over one hundred miles from shore, sediment is being transported at an amazing rate; the motion pictures show not only the water movement (as flourescein dye movement), but the actual movement of the sediment as ripples are destroyed and rebuilt. Such studies as these will help the geologist to know more of the present so that he can better interpret the record of the past.

For years geologists have known that rock outcrops are often found at the outer edge of the continental shelf. For an equal number of years, geologists have stated that these rocks represent areas of nondeposition, for tidal currents at the outer edge of the continental shelf, they have said, are stronger at the bottom. However, there was no record of actual bottom current measurements having been made over a few tidal cycles to ascertain whether or not this hypothesis was indeed true.

Using the Roberts radio current meter, Survey oceanographers went to the edge of the continental shelf and anchored two current buoys with meters suspended be-

neath them. One buoy in 42 fathoms some 12 miles back from the outer edge of the shelf showed normal rotary tidal currents at the surface and near the bottom. The second buoy anchored in 100 fathoms at the very edge showed rotary tidal currents too, but those at the bottom were indeed of slightly higher velocity as had been predicted. The results of this study and of the sand ridge studies are now being prepared for publication.

During the 1960 transfer of the Coast and Geodetic Survey Ship *Explorer* from Seattle to her new base at Norfolk, an opportunity was provided to accomplish a considerable amount of oceanographic investigation en route. Some of these were geological in nature. Some forty cores were routinely taken by using a Phleger corer as the cast weight on the deep oceanographic cast for water samples and deep sea temperatures. The largest portion of these are now at the Scripps Institution of Oceanography where they are being studied by geologists.

On the same trip a new coralline bank was discovered in the Caribbean Sea. This feature with side slopes up to 27 degrees rose from general depths of nearly 1000 fathoms to a least depth of only 15 fathoms. In profile it suggested the spectacular atolls of the Pacific. This particular feature was also being measured by a towed magnetometer while the fathometer was measuring its size. When the magnetic data were worked up, it was found that the negative anomaly over the bank could be interpreted as a tilted block or slab of magnetic material, probably of igneous origin, that formed a core to the non-magnetic calcareous material of the bank. A sample of the surface of this bank is now under study by the Geological Survey.

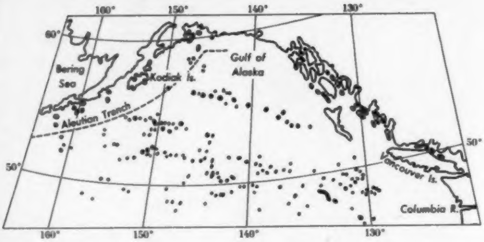
During the 1961 field season, it is quite probable that one or more geologists from the Geological Survey will be aboard Coast Survey ships operating in the Aleutian Trench area and in the Bering Sea. These geologists will monitor the operation of piston and gravity coring operations, will make preliminary field examination of the samples, and then study the samples back in their laboratories.

During 1960, a deep-sea camera provided by the Navy Electronics Laboratory was used from a ship of the Coast and Geodetic Survey. Photographs of manganese nodules were obtained with this camera at depths of over two miles. The Survey now has on order a commercial model deep sea camera and experiments are being planned to use two camera units for obtaining stereo photographs. These photographs are to be used for actual measurements of micro-relief on the ocean floor.

The magnetometer is being brought aboard the Explorer.

Geological Aspects of the Oceanographic Program

The most important phase of the oceanographic program of the Coast and Geodetic Survey is the hydrographic surveying operations and those related activities which provide basic knowledge of the lands beneath the sea. It is only through the information collected from these surveys that knowledge of the greater portion of the earth's surface can be extended beyond the shorelines. Knowledge of the configuration and composition of submarine topography is essential to conclusive studies of geological processes and earth history. Also, the fact that the land-sea boundary and the continental boundaries are transient with geologic time compels explorations of these boundaries and the changing marine environment. Visual evidence on the elevated land cannot be extrapolated into theoretical knowledge of unseen submerged lands. Only by correlating information of under-sea areas and of lands above the sea can there be developed a complete understanding of the evolution of all the earth's surface. Each compliments the other, and despite the great lag in surveys of ocean areas the



Seamounts discovered and surveyed by C&GS ships enroute to and from Western Alaska.

work already accomplished contributes immeasurably to the science of geology.

Hydrographic surveys have provided evidence of great oceanic trenches which mark youthful continental and archipelagic margins. The Aleutian Trench, a major foredeep extending 1200 miles along the Alaska-Aleutian Ridge margin, has been crossed innumerable times by deep-sea sounding lines of the Coast and Geodetic Survey ships. Complete reconnaissance delineation of this feature is now available. Furthermore, the trench will be included in a 250-mile-wide band of basic hydrography to begin in the outer Aleutians in 1961 and to extend eastward to Southeastern Alaska. In addition to the sounding profiles there will be continuous recording from a towed magnetometer as well as gravity observations.

The adjacent abyssal floor of the ocean is found to be dotted with innumerable seamounts, ridges, troughs, and escarpments, which are indicative of major fractures in the earth's crust. Large numbers of seamounts are truncated, and the depths of some wave-abraded crests are greater than a mile. Many are partially if not entirely encircled by moats. These conditions suggest general and local subsidence as well as a rising sea level.

Nearly a million square miles of the northeastern Pacific Ocean have been covered by deep-sea sounding lines made by ships en route to and from Western Alaska and the West coast bases. In recent years each ship devotes three days en route to limited area surveys of major seamounts. More than 150 seamounts have been discovered in this vast region, and 20 major ones form a prominent chain extending 600 miles across the Gulf of Alaska.

Continental Margins

The continental margins have probably attracted more interest and have resulted in more geological discussion to date than any other submarine area. Intensive surveys along selected segments of the coast reveal that there is not a gentle and smooth continental rise to a comparably smooth and relatively broad continental shelf. The rise is very irregular in many areas, and the submarine pattern is confused further in areas where the margins are marked with escarpments. Usually, a relatively steep continental slope marks a separation between shelf and the rise from the abyssal floor. The continental slope might be steeper near the shelf or at the bottom, or at mid-depth. The slope might be smooth or irregular. It is frequently incised by canyons and valleys; occasionally interrupted by broad terraces; and dotted in some areas with knolls and seamounts.

Off southern California the continental slope is interrupted by an extensive borderland which descends to half-mile depths close to the coast. The borderland is dotted with uplifted islands, one being elevated nearly a half mile above sea level, and it is carved into a series of basins, several being more than a mile deep. The borderland terminates at an extensive escarpment on the lower slope. Parallel escarpments along the ridges suggest major structural trends. Transverse trends are similarly suggested by the bathymetric delineations.

In this area and elsewhere along the continental margins there have been revealed numerous submarine canyons, many of major proportions, which incise the slope to depths of more than a mile. Some appear as extensions of rivers or land valleys, but others occur where there is no indication of a coastal drainage system. There is no common agreement regarding the forces and events which are responsible for their origins. There are objections to theories of sub-aerial erosion or to erosion by turbidity currents being the single agent. Continuing geological studies will undoubtedly resolve this controversy as well as the problem of the deeply drowned, truncated crests of seamounts.

Surveys have revealed that the continental margins are not necessarily aligned parallel to coastline. In many areas the straight trends suggest structural control, especially where there are extensive escarpments. Deformation is also suggested by offsets in the alignments of some escarpment-type slopes. A major offset in the continental slope occurs off northern California at Cape Mendocino from which a fracture zone extends far out across the floor of the Pacific Ocean. Here, the mid-slopes north and south of a transverse escarpment 4500 feet high are offset nearly 50 miles.

Prominent continental margin escarpments abound along the southeastern margin of the United States. East of Florida

and the Bahama Islands the margin terminates in a mile-high escarpment rising from abyssal depths. Similarly, the western margin of the broad peninsula platform rises initially from the floor of the Gulf of Mexico on a mile-high escarpment having gradients as steep as 50 degrees. Then, too, on the southern tip in the Straits of Florida the upper slope is marked by an escarpment which, although only 600 feet high, extends over a distance of 70 miles along the slope. It marks the edge of a broad terrace having the characteristics of karst topography. Although these latter escarpments are suggestive of fault origin, it has also been suggested that they are possibly the result of marginal coral reef growth during subsidence. Extensive dredging will shed light on this question. Some dredging has already been accomplished.

Continental shelves are as equally varied as continental slopes. The shelf off western Alaska, north of the Aleutian Islands, is exceptionally wide and smooth. The 250-300 mile width here contrasts with near extinction of the shelf off the southeast coast of Florida. Yet, off the west coast of Florida the shelf width of 150 miles is again exceptionally wide. In some areas the shelves terminate abruptly at a marked increase in gradient at the beginning of the continental slope.

In many areas, however, the outer limits of the shelf are marked by a series of steepening gradients in a zone of transition from shelf to continental slope. The more pronounced change to a gradient greater than 1:100, generally 1:60 to 1:25, probably marks the outer limits of the continental shelf. Although this abrupt change is often considered to occur at a common depth, it has been found at depths ranging from 20 to more than 100 fathoms. Local variations in these depths and the absence of abrupt changes in gradient in some areas tend to cloud general conceptions of a definite edge at the outer limits of the continental shelf. Inasmuch as this edge and the terrace which it bounds relate to a former land-sea boundary, the variations in depth and width reflect variations in erosion, deposition, and even crustal stability.

Most hydrographic surveys have been on the continental shelves and in coastal waters and estuaries. A wealth of information on geological formations and processes has been accumulated in these areas. Most significant were the discovery and survey of numerous dome-like rises on the Louisiana shelf, which heralded the ensuing offshore explorations for petroleum. Several dome-like rises were also discovered in the eastern Gulf of Mexico off Florida, but these features are more likely relict reefs. Nearby in depths of 500-600 feet are a well-preserved lagoon and its barrier spit 60 miles long. It is at the southwest tip of the Florida platform and about 150 feet deeper than the postulated lowest level of Pleistocene seas. Elsewhere on the shelves the discoveries of volcanic plugs, craters, escarpments, glacial troughs and old river channels, rock outcrops and deep sedimentation testify to geological events occurring within the continental margins.

Periodic resurveys in coastal areas provide a record of the geomorphic evolution of shorelines from which the trends of erosion, transportation and deposition of terrestrial sediments can be traced. The continuous retreat of shorelines in many areas and the permanent or seasonal degradation of foreshores may be discerned. Continuous aggradation is evident in some areas where the net effect of the elements favors deposition. Similar conditions prevail inside the coasts, in some bays and estuaries.

Although repetitive surveys in these areas reveal extensive recessions of some shorelines and the erosional effect of waves and currents on submarine topography, the net effect of all the elements is the ever continuing redistribution and entrapment of sediments generally inside the present coastal boundaries. Only at large deltas like the Mississippi, at coastal heads of canyons, and where the continental shelf is practically non-existent are present estuarine and coastal sediments lost forever to the sea. Thus, the dynamic environment in which marine geological processes are now operative is monitored to a large extent by hydrographic surveying. And as already indicated, the extension of comprehensive surveys beyond the continental margins will add immeasurably to knowledge of the changes which have occurred in the primordial surface of the earth.

Geodesy in Support of Geology

In any engineering or scientific undertaking involving extensive areas it is important that surveys, maps, and charts used for basic study are in complete correlation. The delineation of shorelines, the precise location and identification of underwater topography, and certain special considerations such as the detection of earth movement and gravity measurements require precise geodetic control.

Geodesy is a science in which precise measurements are made for the purpose of determining the size and shape of the earth as well as determining geographic

(Continued on page 38)

Geology in Communist China[1] 1960

by E. C. T. Chao

Geological publications stopped in China in 1948 just before the Communist Regime came to power in 1949. A decade has already gone by. Although Chinese geological journals resumed publication since 1953 under the Communist Regime, because of the scarcity of such materials in this country and the language barrier, most geologists in the United States or for that matter in the Free World, are probably not aware of what has taken place since 1950 in mainland China. On this assumption and to facilitate the dissemination of scientific information, the National Science Foundation and the American Association for the Advancement of Science sponsored a symposium on the sciences of Communist China on December 26 annd 27, 1960 in New York City. As a representative of the American Geological Institute I was invited to participate and review the geology of mainland China for the last decade.

There were 25 participants in this symposium, each reviewing his field of interest. These papers will be published within the next few months by AAAS in a symposium volume on the sciences of Communist China. Sources used in this review were mostly provided by the Library of Massachusetts Institute of Technology under a grant from the National Science Foundation. The following is the author's opinion and is not intended to reflect the opinion of the U. S. Geological Survey on the progress and activities in the field of geology in Communist China.

Geological Institutes

In 1950, after the Communist Regime came to power, a geological planning committee was established to review geologic manpower and to plan a survey of mineral resources to support a program of industrialization. In 1952, the Ministry of Geology was established, with J. S. Lee, the noted Chinese geologist, as Director. Under the geological planning committee and the Ministry of Geology, a crash program was launched to train geologists and to explore the natural resources. In this program the first two years were devoted to the survey and estimates of the reserves in coal, iron, and other minerals of critical importance to industrialization and construction as outlined by the first five-year plan. In the latter part of the first five-year plan more than a dozen institutes of geology or laboratories were established in 1956 and 1957. Among them are the Geological Institute of Academia Sinica, the Geological Institute of the Ministry of Geology, the Ch'ang-ch'un Geological Institute and the Lan-chou Geological Laboratory. In addition, geological institutes or laboratories were established under 26 provincial, municipal, or self-governing administrative regions.

Manpower

When I was in China prior to 1945, only a few universities had departments of geology, with a total of about ten to twenty geology students graduating each year for each university. Job opportunities were limited because the geological activities were extremely local. Not more than 200 geologists were actively engaged in geology. Opportunities for advanced training in a traditional manner were available abroad, in Europe or the United States. A few geology students managed to go abroad, getting their advanced degrees and returning to teach in one of the few universities, join the Institute of Geology of Academia Sinica, work for one of several provincial Geological Surveys or the National Geological Survey. Prior to 1950 about one fifth of the 200 active geologists received their advanced training abroad and then returned to work in the above institutions.

According to a paper published in 1959 on the progress in stratigraphy for the last ten years by T. H. Yin, a paleontologist who received his Ph.D. and training in

[1] Condensed from a paper presented at the AAAS Symposium on the Sciences in Communist China, New York, 26 December 1960. The symposium will be published by the American Association for the Advancement of Science during 1961.

France more than thirty years ago, geologists and technicians reached 900 by 1954 and by 1960 there were some 21,000 "geological workers." Here, "geological workers" presumably includes, besides geologists with 4 years of college training, technicians who collect and prepare samples as well as drilling crews with brief geologic training. Also according to Yin, there are three geological colleges, and 47 high- and intermediate-level schools training geologists. Yin reported that in 1959, 19,000 geology students were enrolled in the high-level technological schools and about 25,000 students in the intermediate-level geology schools.

Geologic Mapping and Regional Geology

Prior to 1950, nearly one-half of mainland China, primarily in the outlying provinces, lacked geologic coverage. Geologic mapping of such areas as Sinkiang, the Great Khingan Range, Tsingling and Nanling began during the period of the first five-year plan. Later geologic mapping was extended to Ch'i-lien-shan, Ta-ch'ing-shan, and areas of Si-k'ang and Yunnan. Again according to T. H. Yin, within the first five-year plan period, regional geologic mapping, which is not the same as quadrangle mapping in this country, covered an area of 1,300,000 km^2 at the scale of 1:200,000; and 1,200,000 km^2 at scales ranging from 1:500,000 to 1:1,000,000. In 1958 alone 930,000 km^2 were geologically mapped at the scale of 1:200,000; and 690,000 km^2 at scales of 1:500,000 to 1:1,000,000.

Except some page-sized maps which appeared with articles published in major geological journals, geologic maps from Communist China are not available for inspection. Owing to the general lack of reliable topographic base maps and the limited availability of aerial photography, it would seem reasonable to assume that much of the geologic mapping done in Communist China in the last decade would be of the reconnaissance type. However, the geologic data published on the above areas are available for the first time to the Western World, although much of the information is brief and in Chinese.

Tectonics and Prospecting for Minerals Resources

Several leading structural geologists, J. S. Lee, T. K. Huang, W. Y. Chang, T. Y. Yu, T. C. Sun, C. S. Lee, and K. T. Chen, assisted by Y. M. Sheinman, V. M. Sinitsin, A. S. Khomentovskii, V. V. Beloussov, N. S. Shatskii, Y. A. Kosikin, and others of the U.S.S.R., undertook the supervision of the compilation of the tectonic map of China. The main concept emphasized was that the search for various types of mineral deposits is controlled and should be guided by the nature and characteristics of the tectonic belts and paleogeography. This idea, which obviously is not at all new, has played an important role in the surveying and prospecting of mineral resources.

As a result, in 1959. "*Outlines of the Geotectonics of China*" compiled by the Institute of Geology of Academia Sinica was published by the Science Press in Peking. It is a 320-page explanation text to a geotectonic map at the scale of 1:4,000,000. A review article of this book was published in International Geology Review of AGI (v. 2, no. 12, p. 1095).

Newly Discovered Mineral Deposits

From the geological literature the highlights of some of the newly discovered mineral deposits were reported. Some of the discoveries were announced or are claims which are without geological descriptions. Others were described with regard to the type of deposit so that some idea of the importance of the deposit can be realized.

Siang-Yung Hsia in a short article in 1958 reported that a very large iron deposit similar to the An-shan type has been found in Hsin-yu-hsien of Kiangsi province. The An-shan type of desposit was never suspected to occur in southcentral China. Another large iron deposit of the Hsuan-Lung type of sedimentary origin was reported to have been found in the Tai-mei-chai area in Honan province. Other iron deposits of lesser significance have also been mentioned.

Large copper deposits have been found in Chekiang, in Chung-t'iao-shan and in the Ch'i-lien-shan. Two of these are referred to as disseminated type comparable to the porphyry copper deposits of the United States.

Several large molybdenum deposits, a few similar to the Climax deposit of Colorado, have been found. According to geological reports published in 1959, the authors of these articles claimed that the molybdenum reserve of mainland China is now leading the world.

In addition, those deposits which were lacking before, such as nickel and chromite, have been reported. The discovery of these deposits would appreciably change the mineral resources picture of mainland China.

Tsaidam Basin has been hailed as a potential important oil field. Exploration

for oil also expanded elsewhere in the Szechuan basin and in the great plains of North China, and other areas.

Stratigraphy

Large amounts of stratigraphic and paleontologic data were accumulated as a result of the survey and drilling of coal and oil fields. Again Y. H. Yin reported in 1959 that there are now several thousand "stratigraphers" working in mainland China in 1960. What did they accomplish? First, an atlas of the paleogeography compiled by Liu Hung-yun was published in 1955. Then in 1956 and 1958, the "*Systematic Stratigraphic Tables of China*" in 2 volumes was compiled by the Institute of Geology of Academia Sinica and published by the Science Press in Peking. In addition "*Index Fossils of China*" also compiled by the same institute was published in 1957 in 3 volumes. All three are major work; although not of the superior quality such as some of the equivalent works published in this country, they serve as general reference work in mainland China and deserve the attention of those interested in the geology of China.

The progress in stratigraphy was reviewed by T. H. Yin and in my review paper presented at the symposium I have translated selected passages to give the reader some ideas of the scope of activities that are taking place on mainland China.

Mineralogy, Petrology, Geochemistry and Others

Several new minerals have been proposed but their description so far has been sketchy and incomplete. X-ray diffraction and differential thermal analysis are now employed in mineralogical investigations but are probably limited to only a few research institutes. The number of papers in petrology and geochemistry are few. Little experimental petrology work is being done and radioisotope age dating has just begun. Research as a whole in Communist China is therefore still in its infancy.

What was entirely new since 1950 was the rapid development of groundwater geology and engineering geology, with assistance from the U.S.S.R. Two journals are now in publication: Shuiwendizhi Gongchengdizhi (Groundwater and Engineering Geology) and the Groundwater and Engineering Geology News, both in Chinese.

Soviet Assistance

In the past decade more than 400 Russian geologists and engineers, including many of international fame, have visited China and participated in field geologic work or training programs in China. Many field and laboratory procedures are patterned after the Russians. The number of Chinese papers with Russian abstracts as well as Chinese authors writing in Russian have increased in the last two years. The bulk of the geologic information is, however, still in Chinese.

This, I hope, gives the reader some idea as to what extent geological activities are taking place in mainland China. For further details more than sixty references of recent data are listed in the review article which will appear in the AAAS symposium volume on the sciences of Communist China.

LINDGREN AWARDS ESTABLISHED BY ECONOMIC GEOLOGISTS

The Council of the Society of Economic Geologists has established the Waldemar Lindgren Citation Awards for Excellence in Research. These Awards are named in honor of the late Waldemar Lindgren, distinguished economic geologist, author, teacher, one of the founders of the Society and of the journal, Economic Geology.

Each Award shall consist of an appropriately inscribed Citation and $100 in cash. They will be conferred upon "*geologists whose research as college or university students result in papers of high merit on a subject judged important to economic geology.*"

Any student who is, or who has been within the calendar year in which the paper is submitted, a candidate for a degree in any recognized college or university is eligible to enter the competition.

The papers will be adjudged by a committee, to be known as the Lindgren Citation Awards Committee, drawn from the membership of the SEG Research Committee and appointed annually by the President of the Society.

Up to three Waldemar Lindgren Citation Awards may be made in any one year and will first be awarded in 1962. To qualify for consideration for the 1962 Awards, manuscripts must be in the hands of the Secretary of the Society on or before November 1, 1961. The winners will be announced following the meeting of the Council in February 1962, and the formal presentation of the Awards will be made by the President at an appropriate occasion during the 1962 Fall meeting of the Society.

An Analysis of the

FUTURE DEVELOPMENT *of the* PETROLEUM INDUSTRY IN VENEZUELA[1]

by ANIBAL R. MARTINEZ[2]

The prediction of the future development of the oil industry in Venezuela has great importance, considering the pre-eminent place the industry occupies in the Nation's economy, and the influence oil has in all branches of Venezuelan activity.

The purpose of the study is to present methods for analysis of the future development of the Venezuelan oil industry, using the most rational techniques of prediction developed to the present time. It refers exclusively to the prediction of the liquid hydrocarbons industry. Consideration of natural gas and of solid or semi-solid asphaltic minerals has been completely excluded.

The techniques herein presented are applicable to any non-renewable resource, any place in the world. Reports have been published on the oil industries of the United States (Hubbert, 1959) and Venezuela (Martínez, 1959, 1960). If similar analyses were made for the Middle East and Indonesian basins, a sizable portion of the total world oil resources would have been studied.

DETERMINATION OF THE PETROLEUM RESOURCES OF VENEZUELA

The estimate of the petroleum resources of a country must be based on studies of the geology of each of its sedimentary basins, and on the relationships between the occurrence of petroleum and the type, architecture and geological history of the individual basins. Weeks has discussed these factors in detail (1952, 1958).

The potential volume of oil yet to be discovered in the non-explored portions of the Venezuelan basins is estimated at 16.34 billions of barrels, which, when added to the 29.83 billions of barrels discovered to January 1, 1960, gives a total of 46.17 billion barrels. Considering an additional volume of 23.0 billions of barrels of supplementary reserves,[3] the oil resources of Venezuela amount to 69.17 billion barrels (table).

It should be noted that the foregoing estimates are qualified by present limits of accessibility, economics, etc., whereby small pools with reserves of less than 10 million barrels are not profitable in Venezuela. In the United States, where exploitation is in an advanced stage, Hubbert (1959) estimates that small fields with reserves of 1½ million barrels will ultimately produce more oil than the *giants* of more than 100 million barrels final reserves. On the other hand, Weeks (1950) considers that estimates of oil resources are more likely to be 50 percent larger, than 10 percent smaller, than anticipated.

These considerations suggest to the writer that the petroleum resources of Venezuela may eventually reach 100 billion barrels.

THE INTEGRAL TECHNIQUE OF PREDICTION

The prediction of the future development of a system, or of a certain event, is frequently made on the basis of the extrapolation of past trends or of the more or less regular cycles observed during past behaviour. The integral technique of prediction, developed by Hubbert (1949), is the most rational in the case of the oil industry, however.

[1] Due to space limitations, much explanation has been omitted from the text of this article. The study was presented at the III Venezuelan Congress, Caracas, Venezuela, November 1959; and at the II Arab Petroleum Congress, Beirut, Lebanon, October 1960.

[2] ANIBAL R. MARTINEZ, Regional Geologist, Creole Petroleum Corporation, Maracaibo, Venezuela. Published with permission of the Creole Petroleum Corporation, Mr. W. E. Franks, Manager, Geology Department. The interpretations and conclusions presented in this study are the author's and in no way represent those of Creole Petroleum Corporation. No confidential data of Creole Petroleum Corporation was utilized in the preparation of the report.

[3] A factor of 0.50 was used to calculate supplementary reserves due to increases in the efficiency of recovery of crude oil. This figure, used for Venezuela, compares well with Hubbert's (1959) factor of 0.33 for the United States. Torrey (1960), considering new secondary recovery methods being developed, has increased the U. S. factor to 1.4.

BASIC DATA OF THE VENEZUELAN SEDIMENTARY BASINS

Basin	Area (Km^2)	Net Volume[1] (Km^3)	% Explored of Basin	Cumulative Discoveries (Bbls. x 10^6)	To be Discovered (Bbls. x 10^6)
Maracaibo	55,800	295,000	16	22,942.1	13,460.0
Falcón	35,000	275,000	13	109.1	213.6
Maturín	128,000	333,700[2]	38	6,652.8	2,475.4
Barinas	95,000	167,000	7	127.1	173.2
Cariaco	14,000	21,000	0.3	-	20.9
Totals	327,800	1,091,700	20	29,831.1	16,343.1
Data as of January 1, 1960					29,831.1
				Final Discoveries	46,174.2
				Secondary Recovery	23,000.0
				Resources	69,174.2
				Eventual Definitive Resources	100,000.0

(1) Sediments above -25,000 feet and more than 1,000 feet thick

(2) Excepting tar belts.

Source of Geological Data:
González de Juana and Ponte Rodríguez (1951)
Miller et al (1958)
Renz et al (1958)
Young et al (1956)

The production of petroleum is an irreversible process. The industry constantly depletes its resources, whereas the amount of oil that is generated at the same time is completely insignificant. Therefore, the amount of oil initially present in a sedimentary basin when exploration begins is finite, and the cumulative production of crude will approach, but never exceed, that volume. Only two points are fixed in the production curve: production is *zero* at the beginning of exploitation (time *zero*) and at the end of exploitation (time infinity). The curve rises with a gentle slope from time *zero* during the initial period of development, climbs exponentially during the intermediate period of more or less rapid expansion, stabilizes again to a gentle slope during the final stage, to return to *zero* at time *infinity*.

In the initial stage of development of the industry, the proved volumes at the end of each year considerably exceed the cumulative production, not only due to the relative ease of exploration, but to the physical problem of plant and equipment construction to handle and produce the oil which is discovered (not to mention the acute problem of marketing and prices). Eventually, the amount of proved reserves reaches a maximum. This occurs when more oil is being produced than is being discovered. The intersection of the curves of cumulative production and proved reserves occurs exactly at a point halfway in the evolution of an industry. The curve of proved reserves in its descending phase is symmetrical to that of the ascending phase, because each new discovery is found with more difficulty and produces less volume, finally reaching *zero* at time *infinity*.

Prediction of the Theoretical Development of the Venezuelan Oil Industry

The estimated volume of the petroleum resources of Venezuela (69.17 billion barrels) will now be analyzed, using the integral technique of Hubbert, and an attempt will be made to predict the future development of the Venezuelan oil industry. The source of all statistical data on production and reserves are the *Ministerio de Minas e Hidrocarburos* (1956, 1957) and the *Banco Central de Venezuela* (1958, 1960).

Empirical equations developed by Hubbert (1958, 1959) permit the calculation of the logistic curves of cumulative discoveries, cumulative production, and cumulative proved reserves. These curves, shown in the upper part of Figure 1, aid in the prediction of the development of the Venezuelan oil industry. The derivative curves of rate of discovery, production, and increase of proved reserves are shown in the lower part of Figure 1. Solid lines represent past data, to year-end 1959, and the dashed lines indicate the theoretical prediction of the evolution of the industry until attaining complete depletion of the petroleum resources of the country.

The principal interpretations from the theoretical curves are as follows:

- The hypothetical final year of production is 2016[4]
- Half the development of the industry will occur in the year 1965. In other

[4] No definitive statements can be made as to the final year of an oil industry. Although production may have reached a very low level by year 2016, the curves of discoveries and production are actually asymptotical to the value for resources (Figure 1). Lacking a better term, the expression "hypothetical final year" is used.

words, by year-end 1965 the proved reserves of Venezuela will attain a maximum of 22 billion barrels, and from then on, the production rate will exceed the discovery rate.

- The maximum rate of discovery comes in 1960, and the maximum production rate in 1971.
- The maximum rate of discovery and of production is 3.55 billions of barrels per year, or 9,725,000 barrels per day.

Under normal conditions of world petroleum production and demand the development of the Venezuelan industry could theoretically proceed as indicated. However, a more realistic estimate can be made by taking certain known limitations into consideration. These are:

1) the governmental policy of maintaining production rate at the current level, or a slight increase of less than 4 percent a year, for the purposes of conservation of the oil and preservation of its world price structure (Pérez Alfonzo, 1960), and

2) the current sharp decrease in the rate of discovery.

The rate of discovery in Venezuela has sharply decreased due to markedly diminished exploration activity. On November 1, 1960, there were seven rigs doing exploratory drilling out of a total of 37 active. There were no geophysical parties active in the country, and only two field geological crews working.

The sets of curves that show the possible development of the Venezuelan oil industry, under the assumed limitations, are given in Figure 2. The dotted lines indicate the theoretical curves of Figure 1.

The hypothetical final year of production, as previously defined, is now 2055, or 39 years beyond the date of 2016 calculated above. Although the life of the industry will have been extended only a relatively short time, the additional revenues accruing to the Nation would be considerable.

The curves are asymmetrical, therefore the maxima of proved reserves and the rates of production and discovery occur in or around 1959. The maximum volume of proved reserves at year-end could still reach the figure of 22.0 billion barrels, in any case.

Conclusion

The curves of future development of the Venezuelan petroleum industry presented in Figures 1 and 2 represent the mathematical values determined by means of the integral prediction technique. The curves are not intended to be used to estimate the exact rate of production for a certain year, for instance, nor the status of proved reserves at the end of a given period.

The principal assumption made was that the development of the oil industry, in Venezuela or the world, would continue

FIGURE 1

PREDICTION OF THE THEORETICAL DEVELOPMENT OF THE VENEZUELAN OIL INDUSTRY

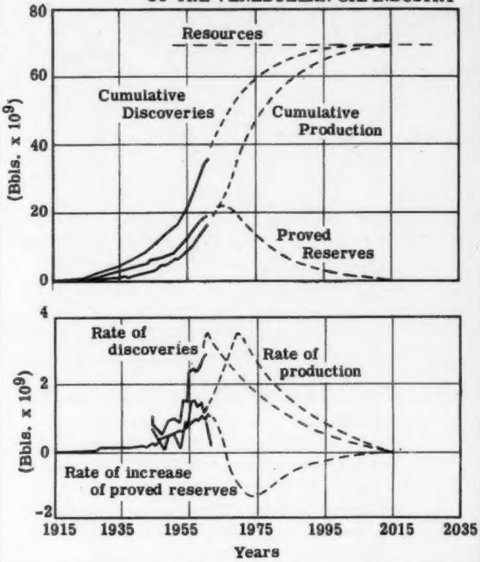
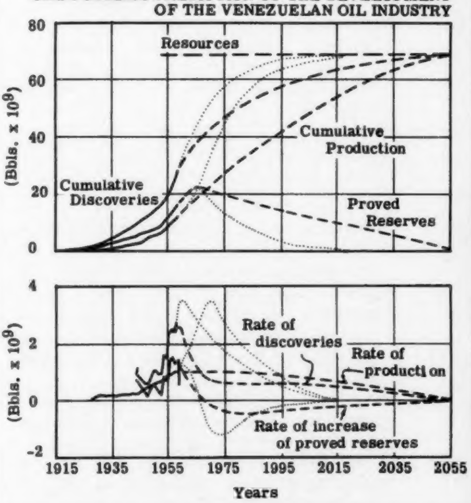


FIGURE 2

ONE POSSIBLE PREDICTION OF THE DEVELOPMENT OF THE VENEZUELAN OIL INDUSTRY



under normal conditions. An infinite number of unpredictable events, not only technical, but economical and political, could interrupt or entirely change the evolution of the system under discussion. The curves may, however, be used as general guides, subject to modification under special conditions.

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INQUA Meeting in Poland

The International Association for Quaternary Research (INQUA) will meet in Poland during the late summer of 1961. The Congress, which meets every four years, will be preceeded by an excursion starting from Warsaw on August 27. The first meeting of the Congress will take place on September 2, and the last meeting on September 7. A post-Congress excursion will be held from September 7 to 21 and will visit the main localities containing Polish Quaternary deposits.

INQUA was first organized during an international geological meeting in Copenhagen in 1928 for the purpose of approaching Quaternary problems on an interdisciplinary level particularly in the fields of geology, archaeology, climatology, and chronology. Although the Congress has been attended primarily by Europeans, it is international and non-Europeans are urged to attend.

All persons interested in the 1961 Congress in Poland may obtain more detailed information by writing to *Professor Rajmund Galon, Secretary General, INQUA, Geographical Institute, University, Torun, Poland.*

INQUA Travel Awards

The National Science Foundation will award individual grants to defray partial travel expenses for a limited number of American scientists participating in the Sixth Congress of the International Association of Quaternary Research, Warsaw, Poland, September 2-7, 1961.

An attempt will be made to have the grants approximate round-trip air-tourist fare between the scientist's home institution and the location of the meeting.

Application blanks may be obtained from the *Division of Mathematical, Physical, and Engineering Sciences, Washington 25, D. C. Completed application forms must be submitted by April 1, 1961.*

GEOLOGY in the Public Eye

by Robert L. Bates

Department of Geology, Ohio State University

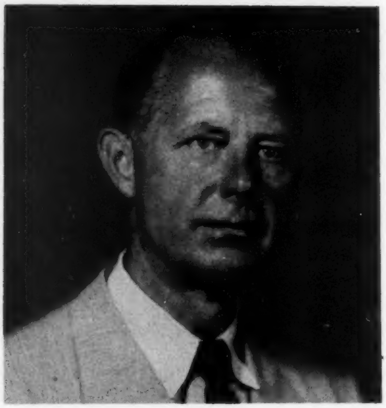
The best career booklet to come this way in a long time is A. K. Snelgrove's *Opportunities in Geology and Geological Engineering*, just published by Vocational Guidance Manuals, 212 48th Ave., Bayside 64, N.Y. Since the author represents no special group or organization, he has no axe to grind, and all fields of geology get equal treatment. The style is readable and the information used is up-to-date. The section on "What Geologists Do" features quotations from several practicing brethren (and two sisters), outlining their day-to-day duties and general responsibilities. A list of institutions offering geology majors is appended. The booklet costs $1.65; if you know a bright high-schooler who might be inclined our way, this is the item . . . *Texas Fossils: An Amateur Collector's Handbook*, by W. H. Matthews III, is the Bureau of Economic Geology's new addition to the growing public-be-served list of state publications. Noteworthy is a systematic description of fossil forms, from algae to mammoths, with 26 figures and 49 plates. Layman, student, and teacher in our second-largest state should be grateful for this report. 123 pages, $1.00. . . . The traveling library of science books of the AAAS has been on the road 6 years now and has visited some 4,000 schools. The AAAS has found, to its surprise, that in the grade schools the topic of No. 1 interest is not space travel or rocketry, but—paleontology. Especially that magic subject, dinosaurs. . . . Apparently carried away by the article of Landes and others on oil resources in basement rocks (AAPG Oct. 1960), a geophysicist at Missouri School of Mines named Zenor put forth some far-out theories of his own and got them published, with illustrations, in *Petroleum Week* for Dec. 30. In letters printed in the January 20 issue, G. J. Poulter of Mobil Oil Co. termed the physicist's article "unmitigated bunk," R. E. Morgan of the School of Mines geology staff disavowed any endorsement by him or his colleagues, and G. H. Davis of Pittsburgh acidly inquired whether Zenor had "considered a course in physical and historical geology." Apparently not, but it was fun while it lasted.

Ing. Guillermo P. Salas, left, holds a zeolite specimen from a collection presented to the Institute of Geology of the University of Mexico by **Dr. Lloyd W. Staples** of the University of Oregon who is currently doing research in Mexico as a Guggenheim Fellow.

NEWS FROM MEXICO

The Institute of Geology of the University of Mexico, at Mexico City was the site of two important geoscience events during the third week of October. The Institute, headed by Director G. P. Salas, sponsored for the first time in its history, a lecture series on *marine geology*. The principal speakers were Dr. F. Bonet and A. Yañez of the Institute in Mexico City and Dr. B. C. Heezen of Lamont Geological Observatory of Columbia University. The meetings were well attended and stimulated interest in research in this field among Institute members, officials of the Mexican Navy, and Petróleos Mexicanos.

The other event was related to the field of mineralogy and consisted of the presentation of a unique zeolite collection to the Museum of Geology of the Institute of Geology, also in Mexico City. The collection was presented by Dr. Lloyd W. Staples, head of the Department of Geology of the University of Oregon, who is doing research as a Guggenheim Fellow this year in Mexico. Dr. Staples is continuing his studies of zeolites, and the Institute of Geology of the University of Mexico has made its facilities available to him. The mineral collection was received by Director Salas in the presence of Dr. A. Barajas, Dean and Coordinator of Science Research of the University of Mexico, Dr. R. L. Miller, chief of the U. S. Geological Survey's Mission in Mexico, and the staff of the Institute of Geology.



Lewis G. Weeks, Past-President of the AAPG is teaching a graduate school seminar course on "The Petroleum Industry" at Columbia University during the current academic year. The course progresses from discussions of the geologic aspects of the origin and accumulation of oil and gas, through world distribution, reserves, economics, company organization, industry philosophy, research, production and concludes with a discussion as to the role and responsibilities of the geologist in the petroleum industry.

Mohole Project Underway

A Project Mohole experimental test hole has been financed through a contract in the amount of $735,750 to Global Marine Exploration Co. of Los Angeles. The contract provides for modification of the drilling ship CUSS-I and the drilling of the experimental hole near Guadalupe Island, off the West Coast of Mexico, in 12,000 feet of water. Previously drilling for petroleum exploration has been confined to water depths of several hundred feet. Plans call for several additional experimental holes to obtain needed scientific, engineering and operating data required in planning the ultimate conquest of the Mohorovicic discontinuity by the drill.

The oil trade journals recently reported the industries first underwater well completion in water 132 feet deep some 6,000 feet off the northern coast of Peru and hailed it as a major technological advance.

The technological advances likely to come out of the Mohole test wells and anticipated improvements in underwater completions may well be significant factors in extending limits of off-shore exploration.

MANPOWER *in a column* –

By HOWARD A. MEYERHOFF

Scientific Manpower Commission
1507 M Street, N.W., Washington 5, D. C.

One of the government's publications that any publisher would put in the best-seller category is the *Dictionary of Occupational Titles.*

Never heard of it! It's the government's Bible for job classification and Civil Service examinations, but the last revision is out of print because it is in such popular demand in private industry. It is a classic of occupational jargon, but it contains more information on job specifications than all other books on the subject of employment in the United States.

The dictionary is now undergoing revision, which may be the one and only revision for the decade of the sixties. The Bureau of Employment Security, Department of Labor, is currently turning to the professions, with a challenge. The scientific and engineering disciplines are not only being asked to bring their classfications up to date. They are also being asked to look five or ten years into the future. What are —and what will be—the major areas of activity? What kinds of specialists will be required?

The Bureau is exceedingly practical in its approach to the task. It does not want the superdetailed type of classification sought in the Register of Scientific Personnel. The latter performs a "Who Knows—And What" function. The Dictionary attempts to define levels of professional and semi-professional training for more or less standardized but graded types of employment.

The staff has its problems in dealing with employers, especially in tagging certain occupations that might, if improperly named, mislead the uninitiated. In Astronomy, for example, a "celestial mechanic" has a well-known field of specialization. But to the unwary layman with a mechanical bent, it might conjure the picture of a mechanic responsible for keeping the planets in their orbits or for the maintenance of space vehicles. Problem: Find another acceptable name.

For earth scientists the revision offers an opportunity to review the existing classification and be sure that it is brought into harmony with current practice and that it anticipates the needs of the immediate future. There are other reasons why this should be done, but here is a reason for doing it at once.

DENVER AAPG-SEPM MEETING

April 24-27

More than 2,400 out-of-towners have made reservations to attend the April 24-27 Convention of the AAPG, SEPM, and Rocky Mountain Sections of the AAPG. The 1,000 member Rocky Mountain Association of Geologists will serve as host; headquarters and technical sessions are in the Denver Hilton Hotel where registration begins on Sunday April 23.

For the AAPG, the Denver convention marks its 46th Annual Meeting, for the SEPM it is the 35th Annual Meeting while, the Rocky Mountain Section of the AAPG is convening for the 11th time.

Fourteen regional papers contribute to the theme, "The Backbone of the Americas." The tectonic history from pole to pole is to be supplemented by 16 short papers on more specific geological and petroleum exploration problems in the U.S. and Canadian Rockies.

Ten other papers of general interest will also follow the theme. On the morning of the 24th, a symposium on "Exploration Research" will be held, sponsored by the AAPG Research Committee. A panel discussion the same evening will review the contents of the symposium papers.

Central Committee

Laurence Brundall, Geophoto Services, Denver, is General Chairman of the Convention. H. H. R. Sharkey, Humble Oil & Refining, is General Vice-Chairman with R. Dana Russell, Ohio Oil Denver, as General Vice-Chairman for the SEPM. Russell is a former SEPM president. Other Central Committee members are Orlo E. Childs, D. M. Evans, R. R. Munzo, and F. A. Thurman.

Room reservations should be received prior to March 24, according to C. L. Severy, 1055 Petroleum Club Building, Denver, Colorado, from whom necessary forms may be obtained.

S.E.P.M. Schedules 43 Papers

A broad spectrum of subjects, technically and geographically, will be contained in the SEPM program and symposia.

Under Chairman Robert Ginsburg, the SEPM technical program opens Monday afternoon with the Research Committee Symposium on Oceanography. Continuation of this symposium carries over to Tuesday afternoon. Thirty five papers will be heard during concurrent sessions on Wednesday. Eighteen deal with sedimentation and sedimentary petrology and 17 with paleontology and stratigraphy.

Nine papers on sedimentation and sedimentary petrology on Thursday morning are followed by an afternoon Symposium on Carbonate Rock Classification. The latter, under the direction of William Ham, winds up the SEPM Convention.

Field Trips, Entertainment Planned

Five field trips, before and after the Convention, will use the RMAG Guidebook, *"Guide to the Geology of Colorado."*

A 3-day trip from April 21-23 covers the Geology of West-Central Colorado, with a post convention trip from April 28-30 to study the Geology of South-Central Colorado.

One day trips include: Geology of the Mountain Front West of Denver (April 23); Stratigraphy and Structure of Colorado Springs, Cañon City Areas (April 28); and Geology of the Front Range Foothills North of Denver (April 28).

Entertainment includes an "Ice-Breaker" cocktail party, old time melodrama, and a chuck wagon dinner-dance with continuous entertainment (bring along casual or western wear!). On tap for Friday the 28th is a combination skiing and sightseeing trip.

Ladies Entertainment is exciting and varied, beginning with a champagne party on Monday. Tuesday, it's "An April in Paris" fashion show and luncheon. On the 27th a campus tour will be followed by lunch at the Officer's Club of the Air Force Academy at Colorado Springs.

Employment Symposium and Interviews

Panel members on Monday morning will discuss the employment situation within the geologic profession. Industry, academic and government representatives will air their views. Causes of the present slack and future prospects are to be voiced, together with evaluations of academic and professional standards of training and education.

Throughout the convention, employment interviews will be held.

AAPG Field Trips

Persons desiring information on the five field trips planned in connection with the Denver AAPG-SEPM meeting, April 24-27, 1961, may obtain a descriptive brochure and registration forms by writing *John R. Hayes, Geology Department, Colorado School of Mines, Golden, Colorado.*

NININGER METEORITES GO TO ARIZONA STATE

The Nininger Meteorite Collection was recently purchased by Arizona State University aided by financial assistance from a private donor, the National Science Foundation and the Arizona State University Foundation. Dr. Carleton Moore, a graduate of Cal Tech, will assume directorship of the Nininger Meteorite Laboratory in June.

In connection with the ceremonies of the inauguration of its new president, Dr. G. Homer Durham, the university will sponsor a two-day symposium on meteorites, March 10-11 at Tempe. The theme of the symposium will be *The Future of Meteorite Research.* A symposium volume will include six papers to be presented orally during the meeting and additional invited and voluntarily submitted papers.

The Nininger Collection contains 1,220 catalogued specimens, plus several thousand small particles, from 684 of the 1,600 meteoritic falls known to world scientists. The specimens have been collected from all parts of the world. This collection, one of the largest in the world, will now be made available for study by reputable scientists. The collection will not be open to the lay public.

Five geological scientists are on the roster of visiting scientist program for junior and senior high schools in Texas under sponsorship of the Texas Academy of Science with support of the National Science Foundation. The men chosen for participation in the program are:

Peter Dehlinger, *Texas A & M College*
Samuel P. Ellison, Jr., *University of Texas*
S. A. Lynch, *Texas A & M College*
William H. Matthews III, *Lamar State College of Technology*
John J. W. Rogers, *Rice University*

Their participation is particularly significant in that the Committee on Curriculum Study in Science of the Texas Education Agency has recommended that earth science be taught in the eighth grade in Texas schools.

NSF Summer Institutes

During the summer of 1961 there will be 395 summer institutes for high school and college science teachers. Grants totaling nearly $22.7 million by the National Science Foundation provide funds for these institutes at 260 colleges and universities. An estimated 20,000 high school and college teachers of science, mathematics and engineering will benefit from these programs.

Sixteen institutes have been awarded solely in geology or the earth sciences and geology or earth sciences will be taught in 48 other institutes along with other sciences and/or engineering and mathematics.

The number of institutes offering earth science has increased significantly over the past several years in response to the demand of teachers for additional subject matter background required for teaching newly introduced earth science courses.

NSF Academic Year Institutes

The National Science Foundation has awarded support to 43 colleges and universities to support Academic Year Institutes for teachers of science and mathematics during the school year 1961-62. The grants total $9.8 million. Earth science is included in the institutes of the following nine schools:

University of New Mexico
Cornell University
Syracuse University
University of North Carolina
Ohio State University
Oregon State College
State University of South Dakota
University of Texas
University of Virginia

FIELD TRIP CALENDAR

Most of the information regarding field trips in this calendar appears through the courtesy and cooperation of the AAPG Field Trip Committee. Corrections, additions and new trip notices should be sent to George H. Fentress, Chairman, AAPG Field Trip Committee, P. O. Box 2585, Denver 1, Colo., with a carbon copy to GeoTimes Calendar, American Geological Institute, 2101 Constitution Ave., N.W., Washington 25, D. C.

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to the COMMITTEE OF 1000 for AGI - 1961

Listed below are the names of nearly 200 persons who have contributed $10 or more in recent weeks to support of AGI as Members of the Committee of 1000 for AGI - 1961. These contributions are vital to the continuing efforts of the American Geological Institute to serve geology and geological scientists. Use the envelope which recently was sent you through the mail—if you can't join the Committee of 1000 through a contribution of $10.00, a smaller contribution will be gratefully received. Help AGI work for you—support AGI.

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Ralph O. Rhoades
Claude M. Roberts
Thomas W. Robinson
Clarence S. Ross
Clyde P. Ross
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Edward Sampson
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Alexander S. Wyner

The New Role of Earth Science in Emerging School Science Programs

by LOREN T. CALDWELL [1]

The kindergarten through twelvth grade science program has undergone many revisions during the last three years. These revisions have included expanded student effort and study time. The science units have been presented with greater deliberateness and pointed toward measured understandings and relationship studies. Many state-level curriculum revisions have been made for K-12 science programs in the public schools. Elsewhere many large and medium sized cities have lead the way toward science curriculum revisions and expansion. In all cases, the local school communities have written their new science programs in the light of revisions made on the state and city levels.

This writer has made two studies of state-level and city level science curriculum revision and expansion for K-12 during the last two years. The first study was made in 1959 and the second in 1960. Rather complete revision and expansion information was received from 25 of the fifty state offices of public instruction. Also ten large city revision programs were received in this first letter canvas made in 1959. Information was requested about the growth of one-year courses in earth science for the secondary schools. The literature received embraced complete science curriculum programs.

The predominant kind of new and expanded science programs organized for the grades K-6 embraced an expanded coverage of the descriptive aspects of all natural phenomena. The new phase of this program was the very conspicuous objective to group natural phenomena into cause and effect patterns and into geographic and space distribution patterns.

The major new-look in the junior high school science programs was a trend toward teaching semi-quantitative science units where the basic laws and principles were taught first and their applications followed. The semi-quantitative science teaching objective means that statistics are converted into measured ratio and proportion concepts. In cause and effect patterns of natural phenomena, the ratio and proportional studies make possible reasonable and accurate value-judgments relative to man's relation to his scientific environments. This would be considered as citizenship science.

In brief, the science program that appeared most commonly among state-wide and city science curricula for grades 7-12 is as follows: Grades seven and eight study the basic and common laws found in physics and chemistry with a concurrent science program on the semi-quantitative concepts of life biology. A proper science background has thus been built in the student's education by the beginning of the ninth grade to enable him to study facts, concepts, and principles found in the earth sciences. In like fashion, the tenth grade student is also able to effectively study ecological biology with a background of science learnings from the 7, 8, and 9 grades.

This writer now turns his attention to the development and educational needs encountered in a one-year earth science course for ninth grade learning in science. A second letter canvas was made by the writer in the fall of 1960 in order to secure progress reports from the states and cities promoting earth science one-year courses in the secondary school science curricula. This study revealed that eight states have rapidly-expanding earth science programs which have been established one year or longer in many of the secondary schools of those states. Four other states are now planning course outlines and teacher guides for a year of earth sciences.

One of the eight states has an earth science program in 175 separate secondary schools. These programs include a one-year course of earth science in their science curriculum at the ninth grade level. All eight of the states with required earth science courses in their secondary school

[1] LOREN T. CALDWELL, Chairman, Earth Science Deparment, Northern Illinois University, De-Kalb, Ill.

science curricula have a total of more than 300 separate secondary schools participating.

Four of the twelve states that reported to this writer about their new and expanding K-12 science programs, indicate that their state curriculum committees have written one-year teacher guides for earth science. The potential development of this earth science course in these four states is very great, since they represent four of the largest in the United States. The Earth Science principles formulated by the state curriculum committee in one of these four states, number 175 listed under the following unit titles: astro-science, physical geography, geology, meteorology, and oceanography. Most state-wide earth science curriculum outlines include the above named unit titles in addition to such titles as basic principles of space science and the scientific aspects of natural resources use.

Earth Science Expands Rapidly

Earth science as a year course in the secondary schools of the United States has expanded with such great rapidity during the last three years that the number of teachers capable of teaching the course are very scarce. Although teacher education institutions and the National Science Foundation summer institutes for earth science teachers have furnished some educated teachers for this task, many teachers now assigned to these courses are in need of teaching aids.

There are few textbooks now on the market which are well fitted to the needs of this secondary school earth science course. Also a number of competitive textbooks are being written and are in the process of being published. These give promise of supplying most of the textbook needs of teacher and students in such an earth science course. Semi-quantitative reference materials dealing with earth science concepts and principles which are usable in such a course are now on library shelves. The teacher needs to have the ability to discriminate between those reference books written with a semi-quantitative treatment and those with the mathematical exactness of technical research literature.

Lack Teaching Aids

The most serious problem encountered by most earth science teachers seems to be the lack of effective mechanical teaching aids for the earth science classroom and laboratories. The aids that are needed for use in the classroom of the partially prepared earth science teacher are effective educational motion picture films and strip films which deal with the major concepts and principles of this earth science course. These motion picture films should perform three principle assists to the earth science teacher. First, the films should show in proper organization and perspective, well-selected natural phenomena demonstrating each major concept and principle in the course outline. Second, they should show laboratory demonstration equipment that can exhibit the natural law or principle shown earlier in the natural phenomena. Third, the films should show scenes of secondary school students at work in a well equipped earth science laboratory containing laboratory equipment of student-quality. Strip films should be available which show the step-by-step routine and material needed in the student laboratory for each topic.

A summary study made by this writer of the eight state-level earth science course outlines now in operation resulted in an outline of study somewhat representative of all. This summary earth science outline consists of the following: six large unit topics; 425 small concepts; and 191 highly desirable earth science principles. The six large unit topics were divided into a total of thirty smaller units or learning projects. It seems logical that teaching aids such as motion picture films, strip films, laboratory equipment, and experiment outlines should be fitted to the thirty smaller units of study and used in the thirty weeks of the school year. These films, film strips, equipment, and laboratory experiments should be planned and produced for use in the thirty weeks of study. It should be assumed that this course could meet four or five days each week with one of the sessions comprising a long multiple period for laboratory study. This laboratory study session could be preceded by the showing of a 15 minute motion picture film and a film strip for laboratory guidance. This pre-laboratory session should have some time for free question and answer between teacher and students. Again during the laboratory session, the film strip should be made accessible to any student at any time as a refresher in guiding the laboratory experiments being performed by students or small groups of students.

Thirty weekly study project titles might be as follows:

1. **Origin and Distribution of Matter in Space.**
2. **Life Cycle of Stars Based on Brightness, Distance, and Color Properties.**
3. **Origin of Solar System Based on its Astronomical Object Members and their Motions.**
4. **The Sky, Star Constellations, and Time Calculations.**
5. **Forces Causing Rocks to Crumble and to be Carried away.**

6. Conditions Permitting Life on Earth to Begin.
7. Marine Lifeforms Adjust to Many New Conditions.
8. Life Adjusts to New Conditions on Land.
9. Varied Land Environments Produce Varied Lifeforms.
10. Crumbled and Dissolved Rocks form New Rock Strata.
11. Igneous Rock Masses Cause Many Landforms.
12. Water Penetrates Surface Rock-Openings as Ground Water.
13. Wind and Glaciers Shape the Earth's Surface.
14. Running Water Alters the Face of the Earth.
15. Origin of Landform Areas Based on Rock Structures.
16. The First 500 Miles Into Space.
17. The Atmosphere's Heat, Water, and Pressure Distributions.
18. Cloud Types Indicate Coming Weather Conditions.
19. Weather Forecasting Based on Air Pressure, Winds, and Air Mass Fronts.
20. Energy Exchanges between The Atmosphere and Ocean Surfaces.
21. Nature and Distribution of Ocean Floor Surfaces.
22. Properties of Ocean Water and Origin of Water Masses.
23. Loction, Nature, and Movements of Ocean Currents.
24. Present Marine Environments Favorable to Lifeforms.
25. Minable Rock-Minerals and Fuels.
26. Natural Reserves of Usable Water.
27. Natural Forces Determining Conservation Practices.
28. Native Plants as Indicators of Soil, Surface, and Climate.
29. Present State of Man's Space-Environments Knowledge.
30. Man's Mechancal, Navigational, and Biological Space Travel Capacities.

The earth science course in ninth grade is only one of the steps in an effective K-12 science program but the course should give meaning to the natural application of all sciences and give students a natural interest in any science for the rest of their life. In this K-12 science program, it seems apparent that most present-day state and city school science curriculum committees believe that science for all students should be completed at the end of the tenth grade with an effective course in ecological biology where the scientific aspects of human health and man's nutritional problems are considered as a part of the ecological biology around man.

Specific and mathematically quantitative courses in any of the leading science fields should be offered for students during the eleventh and twelfth grades. Here some courses are appearing in addition to the traditional biology, chemistry, and physics. Space astronomy, meteorology, oceanography, and spherical geometry are appearing as electives in the secondary school curricula as special interest offerings for students with special abilities in these fields.

Summary

In summary, six years of patterned descriptive science for K-6 should prepare the seventh grade student for his new semi-quantitative science learning experiences which start in seventh grade. These consist in the seventh grade of new mathematics learnings, and two concurrent science learning sequences of natural laws in biology and physics-chemistry. An effective earth science course for ninth grade and a dynamic course in ecological biology for tenth grade should give the K-10 grade science program the punch which present society is requiring of its good citizens. Such a 10 year general education science program should recruit more capable science students for special science education in the senior high school 11th and 12th grades. It should give to the junior colleges, science students capable of proper college-level education in the sciences. This paper has cited some ways by which an earth science course in the ninth grade can strengthen a K-12 science program in the general education science curriculum.

Aid for Overseas Students

An outstanding foreign student will receive a $750 scholarship to study geophysics in the United States from the Society of Exploration Geophysicists this year. Announcement of the grant was made by SEG President J. P. Woods. The winner will be chosen from nominations made by affiliated societies in Europe, South America, and Africa, and by SEG members working in other countries.

"This scholarship is the second step in the SEG's 'people-to-people' program of aid to geophysical education and research throughout the free world," Woods said. "In 1960 the society awarded four scholarships totaling $2,000 in Canadian universities, and this year we have available $5,000 to support studies by foreign students in countries where geophysics is taught." More than 1,000 of the 5,600 SEG members are employed outside the United States.

ГЕОЛОГИЯ = 地質 = Geology

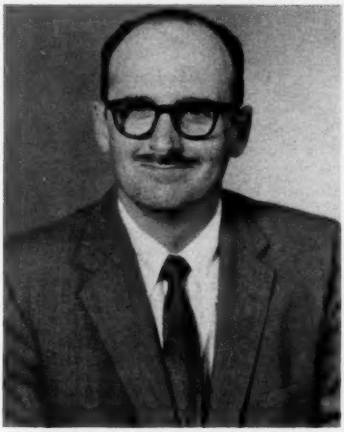
geology translations news

Geology behind the language barrier figured highly in the news recently. Reports by Drs. E. C. T. Chao and Kung-ping Wang, AGI-sponsored participants in the Symposium on the Sciences in Communist China were front-page news in the New York Times and other papers throughout the country. The symposium, was the American Association for the Advancement of Science's ninth annual Conference on Scientific Communication, and was held in New York City, December 26 and 27, 1960 with the aid of support from the National Science Foundation. Dr. Wang reported on the status of mining and metallurgy, and Dr. Chao on the progress and outlook of geology. What made the headlines was their mutual conclusion that intensive geological prospecting in the last decade has disclosed mineral resources so extensive that they appear to make China one of the world's chief reservoirs of raw material. A condensation of Dr. Chao's report to the symposium appears elsewhere in this issue of GeoTimes. The full reports of all participants will appear in a symposium volume to be published by the AAAS.

A significant feature of Dr. Chao's report is a review of the geological literature being published in Communist China. Six major Chinese journals were singled out for special attention and eight others were cited as regularly containing significant material. Of the six major ones, three deal with all disciplines, two with paleontology, and one with groundwater and engineering geology. One book reviewed by Dr. Chao, "*Outlines of the Geotectonics of China,*" has been recommended for translation by the AGI Translations Committee. Means of systematically screening the journals cited in the report are being sought under the AGI translations program.

From his reviewing and scanning of some 25,000 pages of literature from China, most of it published since 1953, Dr. Chao concludes that geological research in China is still in its infancy. He adds, however, that much geological information has already been accumulated and that a vast amount can be expected in the next generation.

The unusually great interest shown in the symposium, not only by scientists but by commercial and government specialists as well, is a striking example of the need for increased awareness and utilization of information published in the so-called exotic languages. Geologists certainly have as much to learn from the foreign literature as any other group of scientists.



Peter T. Flawn has been named Director of the Bureau of Economic Geology and Professor of Geology at The University of Texas. Dr. Flawn has been on the staff of the Bureau since 1949. He holds membership in GSA, AAPG, AGU, AIME, SEPM, and Asociacion Mexicana de Geologos Petroleros. Since 1956 he has served as Chairman of the AAPG Basement Rocks project Committee and as a member of the AAPG Research Committee.

MUSKEG RESEARCH CONFERENCE

A two-day muskeg research conference will be held at McMaster University, Hamilton, Ontario, on 18 and 19 April 1961. This conference is the seventh annual meeting and is sponsored by the Associate Committee on Soil and Snow Mechanics of the National Research Council of Canada. In connection with the theme, "Muskeg in Relation to Northern Development", papers will be presented which will consider phases of research, design and practice as they pertain to engineering problems arising from muskeg. A field trip is planned to demonstrate the use of sampling and strength testing equipment. Anyone interested is invited to attend the conference. Inquiries should be directed to *Mr. I. C. MacFarlane, c/o Division of Building Research, National Research Council, Ottawa 2, Canada.*

AGI DATA SHEET 23

by

Donald W. Peterson [1]

Compiling a classification is a formidable task, particularly in a field as complex and varied as igneous rocks, as few geological topics are subject to such widely diverse opinions. A perfect consensus on nomenclature is impossible because of: 1) various historical lines of development in study and nomenclature; 2) opposing viewpoints on the criteria for naming, the position of boundaries, and the definition of names; and 3) different purposes served by the well-established systems.

Data sheet 1a shows chiefly how the most common rock names are used and places them in a framework adaptable to use both in the field and the laboratory. The scheme is simple and is adapted from similar charts in general use. Data sheet 1b briefly explains the use of the chart and its limitations, and it indicates a few common rock names whose definitions depend mainly on texture.

Most rock classifications, including that of Data Sheet 23, Table 1, are primarily designed for rocks that contain quartz and alkalic feldspar, and they are not well adapted for classifying rocks without these minerals. A profusion of names has been applied to the large assemblage of rocks poor in quartz and alkalic feldspar, and Data Sheet 23, Table 2 is a scheme suggested by Everett D. Jackson of the U. S. Geological Survey for classifying these rocks, employing some of the more usable names from this group. Table 2 is essentially an expansion of the lower right-hand part of Table 1. Data Sheet 23, Table 3 includes a short glossary of rocks not easily adaptable to pigeon-holing, and of names perhaps even more controversial than those included in Tables 1 and 2. The selection of names for Tables 2 and 3 is necessarily incomplete, and perhaps other names deserve a place instead of some that were included. It is hoped that the omissions are not serious. A growing and commendable practice avoids the use of many uncommon names by prefixing appropriate mineral modifiers to a common rock name. This practice should be followed where possible, but under some circumstances it is simpler and more convenient to use the uncommon name. For example, a tedious repetition of "dark biotite-bearing nepheline-augite syenite" could be avoided with "shonkinite." The less common names serve a useful purpose, but they should be used with care and should not be unnecessarily multiplied. A commonly used classification chart for lamprophyres is appended to the glossary.

Certain criteria in the setting up of any classification are controversial, and these aspects merit a short explanation. The decision of what to include in "alkalic feldspar" is one of the most troublesome. Some schemes, such as Johannsen's (1939), restrict it to "potash feldspar" and include the K-feldspars and microperthites, whereas others add all perthites and modal albite (An_{0-10}) and use the term "alkali feldspar" or preferably "alkalic feldspar." Both viewpoints are supported by valid reasoning; the problems are well discussed in several of the references, such as Williams, Turner, and Gilbert, 1954, p. 34; Shand, 1951, p. 235-240; Hatch, Wells, and Wells, 1949, p. 186-187; Grout, 1932, p. 47-48. "Alkalic feldspar" is used in this chart because: 1) it provides a more even distribution of rocks among the different categories; 2) it is the preferred system of a majority both of individual geologists and of those references consulted. Opponents to this view argue that modal albite is not megascopically distinguishable from other plagioclase. The reply is that if during field work albite is inadvertently included with plagioclase, no great harm is done. Very often megascopic identifications must be modified after microscopic study, even when plagioclase composition is not an essential criterion, and in later field studies the names are adjusted to fit the improved data. Those who continue to prefer using K-feldspar only are at liberty to change the definition on the chart; most authors will feel the need to clearly define their terms regardless of their viewpoint.

Quantitative mineralogical boundaries between rock types comprise one of the most persistent problems of a consensus scheme, for no two established systems follow the same pattern. A partial example of the diverse views is shown in figure 1, in which the framework of several different classifications has been modified to correspond to the layout of the present data sheet. This modification distorts certain features of some of the schemes, but boundaries and pigeon-holes are roughly preserved in a manner by which they can be compared with one another. The boundaries between rock types on the present chart were selected on the bases of convenience and compromise, but they need not be regarded as rigid. Under certain conditions, a geologist may find it de-

1 Donald W. Peterson, compiler of Data Sheet 23 is a member of the staff of the U.S. Geological Survey, Menlo Park, Calif.

DESCRIPTIVE MODAL CLASSIFICATION OF IGNEOUS ROCKS

by Donald W. Peterson

The classification of Table 1 shows the names most commonly applied to igneous rocks. It represents a limited consensus on usage of the terms, and it is intended simply to be an aid in naming the more common igneous rocks. The classification is not intended to supersede other schemes, nor to replace schemes with other purposes. Neither does it represent any effort at dictating a standard or universal scheme of rock classification. Table 2 is an expansion of the lower right hand part of Table 1.

Most of the names shown are based on grain size and relative abundance of quartz and feldspars. The approximate color index and range of the An content of plagioclase are given below the rock names. Color index is a supplementary rather than an essential criterion in naming the rocks. The plagioclase An content is needed only for identification of modal albite, in distinguishing between the diorite and gabbro clans, and in recognition of eucrite, allivalite, and harrisite on Table 2; for other rocks it is supplementary. Ideally, the distinction between the diorite and gabbro clans is based on both color index and plagioclase composition; however, where these criteria conflict either may be used, depending on geologic circumstances, affinities of the rock, and judgment of the investigator.

Because the names are based on volume percent of minerals, most can be applied accurately only after laboratory study. They can be used in the field with moderate accuracy by omitting plagioclase composition as a definitive criterion and by placing more reliance on the approximate color index.

Because names of fine-grained rocks are generally based on composition and amounts of phenocrysts, they may not accurately represent the bulk composition of the rock, and correlation between fine- and coarse-grained members of a clan should be regarded as rather loose. Distinctions between fine-grained rocks are rather indefinite, and the boundaries are shown on the chart as dashed lines.

The definitions of the following common rocks depend largely on texture or occurrence.

APLITE—A dike rock consisting almost entirely of quartz and feldspar and having a characteristic fine-grained sugary texture. The name sometimes implies granite aplite, but aplites of other composition are common.

LAMPROPHYRE—A group name for dark, porphyritic to panidiomorphic dike rocks that contain abundant euhedral mafic minerals, commonly of two generations; generally feldspars are restricted to the groundmass, and some lamprophyres lack feldspars. Lamprophyres range from syenitic to gabbroic and are transitional into ultramafic; they commonly are alkalic.

PEGMATITE—Holocrystalline rocks that are at least in part very coarse grained, whose major constituents include minerals typically found in ordinary igneous rocks, and in which extreme textural variations, especially in grain size, are characteristic. (Jahns, R. H., 1955, Econ. Geol. 50th Anniv. Vol., pt. II, p. 1030).

PORPHYRY—Two widely divergent definitions are in common use:

1) A hypabyssal rock containing phenocrysts. "Granite porphyry," etc. imply that phenocrysts are set in a fine-grained phaneritic matrix; "rhyolite porphyry," etc. imply that phenocrysts are set in an aphanitic matrix. Long and common usage gives authority to this definition, although certain inconsistencies are apparent, and names that depend on occurrence (hypabyssal) are undesirable. According to this definition, extrusive and plutonic rocks should never be called "porphyry," but instead be described as "porphyritic."

2) Any porphyritic rock with more than a certain minimum amount of phenocrysts (10%, 12%, 50%, or "abundant" are advocated by various authors). Proponents logically claim that a rock name should be valid regardless of mode of occurrence of the rock, but this definition is contrary to much common usage.

This chart, being a consensus, tolerates either definition, but urges that to avoid confusion and controversy, the name "porphyry" be used only when absolutely necessary, and then be restricted to porphyritic hypabyssal rocks.

Additional copies of this data sheet may be obtained from the AMERICAN GEOLOGICAL INSTITUTE, Cost 0.10.

sirable or necessary to shift a boundary, particularly if a group of rocks falls across it. Those who feel strongly for a 5 percent instead of a 10 percent limit of quartz in syenite, monzonite, etc., may wish to change the chart accordingly.

Figure 1 shows that dellenite, rhyodacite, and dacite have no uniformly established definitions or limits; this is mainly because the distinctions are based on differences of relative proportions of phenocryst minerals that comprise only a fraction of the volume of the rock. A natural consequence is that the terminology is rather vague. The scheme adopted on the present chart follows Nockolds' classification (1954) most closely because it permits the retention of the intrusive-extrusive symmetry of the chart and because each of the well-established names has a distinct position. The other systems are reasonable, however, and the boundary lines on the chart should be considered flexible. Megascopically, and even microscopically for rocks with small phenocryst content, the finer distinctions may imply a misleading degree of accuracy, but good judgment and common sense will aid in assigning a reasonably accurate pro-

TABLE 1

DESCRIPTIVE CLASSIFICATION OF IGNEOUS ROCKS						
1 2	Alkalic feldspar[3] >2/3 total feldspar	Alkalic feldspar[3] 1/3 to 2/3 total feldspar	Plagioclase 2/3 to 9/10 total feldspar	Plagioclase >9/10 total feldspar: An <50	Plagioclase >9/10 total feldspar: An >50	Feldspar <10%
	Color index (CI) 0–20±[4]	*Color index (CI) 10–40*[4]			*Color index (CI) 40–70*[4]	*Color index (CI) >70*[4]
Quartz >10%	*RHYOLITE*	*DELLENITE ≡ QUARTZ LATITE*	*RHYODACITE*	*DACITE*	*QUARTZ BASALT*[5]	Extremely rare.
	GRANITE CI 5–15 An 0–15	ADAMELLITE ≡ QUARTZ MONZONITE CI 10–20 An 12–33	GRANODIORITE CI 15–30 An 25–40	TONALITE ≡ QUARTZ DIORITE CI 25–40 An 35–50	QUARTZ GABBRO[5] CI 40–70 An 50–90	
	ALASKITE CI <5 An 0–35		TRONDHJEMITE CI <10 An 15–30			
Quartz <10% Feldspathoids <10%	*TRACHYTE*	*LATITE*	*ANDESITE*		*BASALT*	PERIDOTITE Pyroxene and olivine
	SYENITE CI 5–25 An 0–30	MONZONITE CI 20–35 An 25–45	DIORITE CI 25–40 An 35–50		*DIABASE (≡DOLERITE)* GABBRO CI 40–70 An 50–100	PERKNITE Pyroxene and/or amphibole DUNITE Olivine.
Feldspathoids >10%	*PHONOLITE*	*FELDSPATHOIDAL LATITE*	*FELDSPATHOIDAL ANDESITE*		*FELDSPATHOIDAL BASALT*	Great variety of uncommon rocks
	FELDSPATHOIDAL SYENITE Includes many varieties of uncommon rocks.	FELDSPATHOIDAL MONZONITE Rare.	FELDSPATHOIDAL DIORITE Rare.		FELDSPATHOIDAL AND ALKALIC GABBRO Includes many varieties of uncommon rocks.	

[1] Fine-grained, commonly volcanic rocks shown in italics; coarse-grained, commonly plutonic rocks in gothic letters; less common rocks of both varieties are in small print. Excepting diabase, names reflecting special textures are not shown, but some of these are defined briefly on the reverse side.

[2] Amounts of minerals based on volume percent.

[3] Includes K-feldspar, perthite, and modal albite (An_5–An_{10}).

[4] Defined as the total percent of dark minerals (biotite, amphibole, pyroxene, olivine, opaque oxides, etc.).

[5] Quartz basalt and quartz gabbro may be used if quartz exceeds 2 or 3 percent.

visional name until visual observations can be supplemented with chemical data.

Authorities vary on the definition and classification of the area between syenite and diorite, and figure 1 shows several different treatments. The scheme of Data Sheet 23, Table 1 again is a consensus.

Means of separating the diorite and gabbro clans according to different authorities are shown in figure 2. Most systems use plagioclase composition as the fundamental distinguishing criterion, with color index either secondary or not essential. In practice, plagioclase composition is impossible to use in the field and sometimes difficult to determine even microscopically, especially if plagioclase is zoned or if a suite of rocks falls across the borderline. So, as indicated on Data Sheet 23, and in figure 2, borderline rocks may be classified in accord with geologic circumstances and the best judgment of the investigator. Ellis (1948) has reviewed comprehensively the problems of separating diorites from gabbros, and his statistical study provides a factual base from which Hatch and others (1949), Williams and others (1954), and the present study have located the diorite-

TABLE 2

DESCRIPTIVE CLASSIFICATION OF IGNEOUS ROCKS POOR IN QUARTZ AND ALKALIC FELDSPAR		
[1]	Plagioclase >10% of rock	Plagioclase <10% of rock
Pyroxene <10% Olivine <10%	*Hornblende basalt*	*No volcanic equivalents*
	Anorthosite (plagioclase only) CI 0–10 An 50–100 **Hornblende gabbro** CI 10–90 An 30–80	**Hornblendite** (hornblende only) CI >90 **Biotitite** (biotite only) CI >90 **Chromitite** (chromite only) CI >90
Pyroxene >10% Olivine <10%	*BASALT*	*No volcanic equivalents*
	DIABASE (≡ DOLERITE) (fine-grained gabbro with ophitic texture)	PYROXENITE CI >90
	GABBRO (Clinopyroxene dominant) CI 10–90 An 50–100 **Norite** (orthopyroxene dominant) CI 10–90 An 50–100 **Eucrite**[2] (both pyroxenes) CI 20–90 An >70	**Bronzitite** (orthopyroxene dominant) CI >90 **Websterite** (both pyroxenes) CI >90 **Augitite** (clinopyroxene dominant) CI >90
Pyroxene >10% Olivine >10%	*OLIVINE BASALT* *Ankeramite* (augite exceeds olivine, low in plagioclase)	*No volcanic equivalents*
	OLIVINE DIABASE	PERIDOTITE CI >90 **Harzburgite ≡ Saxonite** (orthopyroxene dominant) CI >90 **Lherzolite** (both pyroxenes) CI >90 **Wehrlite** (clinopyroxene dominant) CI >90
	OLIVINE GABBRO CI 20–90 An 50–100	
Pyroxene <10% Olivine >10%	*PICRITE BASALT ≡ OCEANITE*[3]	*No volcanic equivalents*
	TROCTOLITE CI 10–90 An 50–100 **Allivalite** (plagioclase dominant) CI 10–50 An >90 **Harrisite** (olivine dominant) CI 50–90 An >90	**Dunite** (olivine only) CI >90 **Kimberlite ≡ Mica peridotite** (olivine and phlogopite) CI >70
Feldspathoids >10%	*FELDSPATHOIDAL BASALT* *Tephrite* (nepheline and/or leucite, no olivine) *Basanite* (olivine tephrite)	*Limburgite* (analcite, augite, olivine, and glass) *Katungite, Ugandite, Mafurite* (melilite, leucite, kalsilite, respectively, with olivine)
	FELDSPATHOIDAL and ALKALIC GABBRO[4] **Teschenite** (analcite and augite) **Theralite** (nepheline and augite) and many others.	**Urtite, Ijolite, Melteigite** (nepheline and aegirine, in order of decreasing nepheline) CI 30–70 **Fergusite** (leucite and augite) CI 30–50 **Alnöite** (melilite, olivine, and biotite) **Uncompahgrite** (melilite, pyroxene) and many others.

[1] Fine-grained commonly volcanic rocks shown in italics; coarse-grained, commonly plutonic rocks in gothic letters. Family names shown in upper case; less common families in smaller print. Varietal names shown in lower case. The classification is based on the presence or absence of plagioclase and the relative proportions of pyroxene, olivine, and feldspathoids. If further information is essential to the definition, it is indicated in brief notations. Amounts of minerals based on volume percent. Color index (CI) defined as the total volume percent of dark minerals.

[2] Le Bas (1959, Geol. Mag., v. 96, p. 497–502) discusses the widely divergent definitions of "eucrite", and recommends that the term be dropped and replaced by gabbro. Eucrite is included here only because it is frequently used in the literature.

[3] Some picrite basalts and oceanites may contain more than the indicated 10 percent pyroxene. Their essential distinguishing factor is that olivine exceeds pyroxene.

[4] Alkalic gabbros grade into feldspathoidal syenites and monzonites at one end and into ultrabasic rocks on the other. Distinction between types is especially poorly defined.

gabbro boundary. A familiarity with Ellis' paper will be helpful to any who are concerned with terminology problems associated with this boundary.

Those who use this classification should not regard it as rigid, but as a helpful and flexible tool that can be applied to fit varying geological conditions. A simple chart cannot substitute for the more adequate treatment of textbooks and journal papers, and references to such discussions are listed below.

Acknowledgments.—Most of the background for this classification has come from the listed references and from several unpublished charts used in colleges and universities. The author wishes to express his gratitude to Everett D. Jackson and to the many other geologists who have offered both written and oral suggestions to experimental versions of the chart; all have had an important part in the development of this classification. Mary Lou Conant assisted with the final editorial review of Data Sheet 23 and Mrs. Betty Small aided greatly in planning the diagrams for effective presentation and in the drafting of the illustrations.

LIST OF ROCKS NOT ADAPTABLE TO THE CLASSIFICATION CHARTS, AND LAMPROPHYRES

TABLE 3

Bostonite.—Aplitic alkalic syenite, sugary to trachytic texture (the trachytic texture is essential to some classifications, not to others).

Charnockite.—Orthopyroxene-bearing granitic type rock; generally regarded as metamorphic.

Comendite.—Light-colored pantellerite, a sodic rhyolite containing sodic amphibole or pyroxene.

Essexite.—A pyroxene-rich alkalic gabbro with essential nepheline in some usages; with essential alkalic feldspar in others.

Foyaite.—Leucocratic, coarse-grained nepheline syenite.

Hyperite.—Used variously as a general name for gabbro, an equivalent for norite, and as a synonym for olivine-bearing norite.

Kentallenite.—A dark monzonite, subequal amounts of augite, olivine, orthoclase, and plagioclase.

Keratophyre.—An albitized rock, the intermediate member of the spilite suite; composed of albite and of small amounts of pyroxene and/or amphibole which may be altered to chlorite. Those carrying quartz are called quartz keratophyre, and comprise the siliceous member of the spilite suite.

Liparite.—A synonym of rhyolite not much used in North America.

Malignite.—Mafic feldspathoidal syenite to alkalic gabbro, mainly aegirine augite, nepheline, and orthoclase.

Mugearite.—Variously called oligoclase basalt and olivine-oligoclase andesite; major phenocrysts oligoclase, olivine, and orthoclase; low SiO content, trachytic texture.

Nordmarkite.—Quartz-bearing syenite, chiefly of microperthite.

Pantellerite.—A dark-colored sodic rhyolite with relatively abundant alkalic mafic minerals.

Shonkinite.—Varies from dark syenite to alkalic gabbro; chiefly augite and orthoclase, variable nepheline, olivine, plagioclase, and biotite.

Spilite.—"Spilite suite" is family of igneous rocks rich in Na-plagioclase and low in K-feldspar, generally considered to have formed by alteration processes. Spilite is the least siliceous, most calcic member, generally defined as albitized basalt.

Tholeiitic basalt.—Briefly defined as basalt without olivine. Tholeiitic magma is a type of basaltic magma containing little or no olivine, about saturated in silica, and yielding over-saturated late differentiates.

Trachyandesite.—Many divergent definitions; generally used as a synonym of latite.

Trachybasalt.—Many divergent definitions; a possible consensus is a K-rich basalt with plagioclase (An >50).

LAMPROPHYRE

Type of feldspar / Dominant mafic mineral	Feldspar is chiefly alkalic feldspar	Feldspar is chiefly plagioclase	No feldspar
Biotite	MINETTE	KERSANTITE	ALNOITE OUACHITITE
Pyroxene and/or Amphibole	VOGESITE	SPESSARTITE ODINITE	
Alkalic pyroxene and/or Alkalic amphibole	SODIC MINETTE SODIC VOGESITE	CAMPTONITE	MONCHIQUITE FOURCHITE

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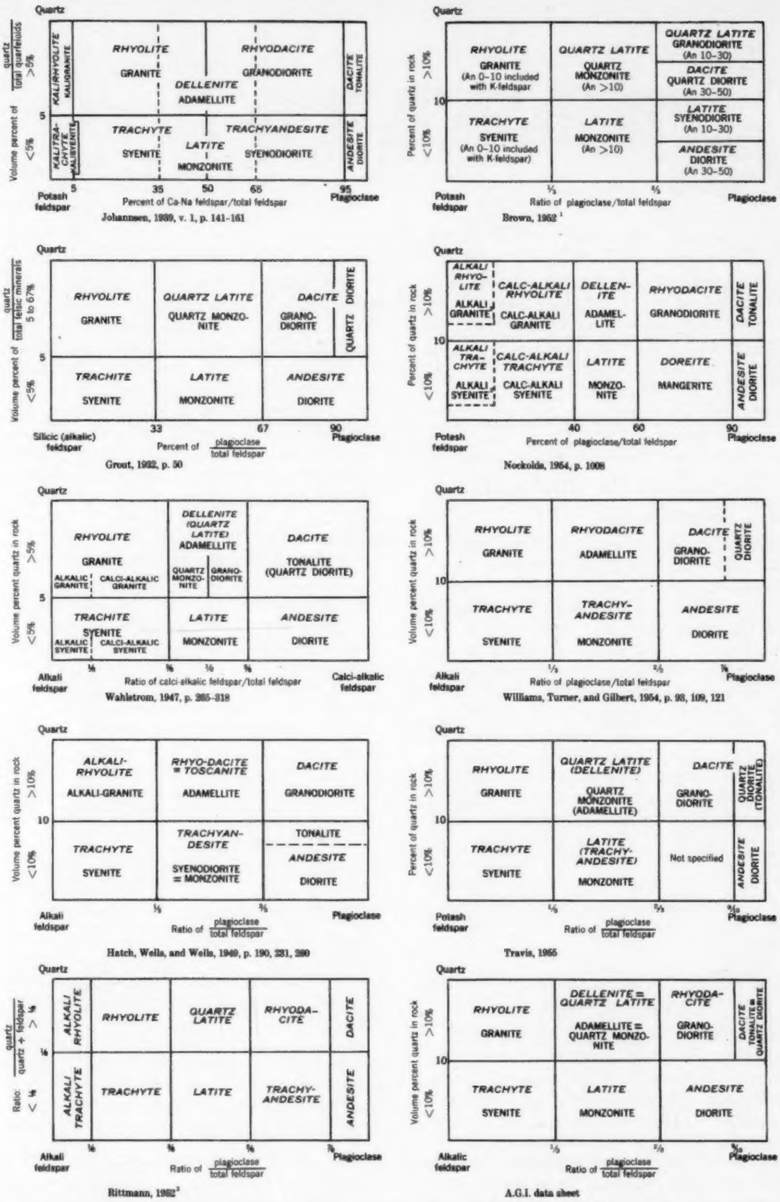

[1] This system has been officially adopted by the Canada Geological Survey. The diagram is distorted from the original because plagioclase composition is a major criterion for separation in Brown's definitions.

[2] Alkali varieties contain essential alkali feldspar (potash feldspar, or albite, or both).

[3] Diagram is somewhat distorted from Rittmann's original scheme to fit the present layout.

Figure 1. Comparisons of modal classifications of common igneous rock names and their bounding limits, as used by different classifications.

The framework of the different schemes has been adjusted to resemble the layout of the AGI data sheet to permit easy comparisons. In making the adjustments, some features or definitions may have become distorted, and the above charts do not necessarily convey the exact sense of some meanings as intended by the original author. The schemes of Shand (1951) and Niggli (1954) could not be properly adapted to this type of framework.

Terms for each chart are spelled and applied following usage by the original author. "Potash feldspar" includes K-feldspar and microperthite; "alkali feldspar" includes K-feldspar, perthite, and modal albite (An_0—10).

Author	Diorite-Andesite Criteria	Gabbro-Basalt Criteria	Notes
Kemp, 1911	Contain biotite and hornblende	Contain pyroxene	Later schemes abandoned dark minerals as criterion because of lack of consistency, but they sometimes are a useful aid.
Johannsen, 1931, 1939			Detailed specific names for all possible combinations.
Grout, 1932	Medium plag. (An_{20-50}) > 2/3 total feldspar	Basic plag. (An > 50) > 90% total feldspar	CI not a criterion.
Wahlstrom, 1947	An < 50	An > 50	CI not a criterion.
Ellis, 1948	An < 47-48 CI < 40 Biotite and hornblende (subordinate pyroxene)	An > 47-48 CI > 40 Pyroxene (subordinate hornblende)	Discusses 4 criteria: 1) kind of dark mineral, 2) plagioclase composition, 3) color index, 4) chemical composition.
	Name best determined by judicious use of criteria and from rock affinities.		Limits are not rigid. Appropriate modifiers may be prefixed.
Hatch and others, 1949, p. 257-259	An < 50 CI < 40	An > 50 CI 40-90	Plag. composition is major criterion. If An < 50 and CI > 40, rock is "meladiorite". If An > 50 and CI < 40, rock is "leucogabbro".
Shand, 1951	CI < 30 (leucocratic)	CI 30-60 (melanic)	CI is major criterion. Subvarieties are designated for some variations in plag. composition.
Rittmann, 1952	CI < 40	CI > 40	Plag. composition not a criterion.
Brown, 1952	An 30-50 CI 10-40	An > 50 CI 40-70	Plag. composition is major criterion. CI is a field supplement.
Barth, 1952	CI < 30 (leucocratic)	CI 30-60 (mesotype)	Plag. composition not a criterion.
Niggli, 1954	An < 50	An > 50	CI not a criterion.
Williams and others, 1954, p. 32-36, 48-49, 106-107	An < 50 CI 10-40	An > 50 CI 40-70	Plag. composition determines name in borderline cases. "leuco" or "mela" prefixed if CI disagrees with An.
Nockolds, 1954	plag., but limit not defined		Distinction based on "nature of the plagioclase feldspar present", not on kind of dark mineral or color index (p. 1009).
Travis, 1955	An < 50	An > 50	CI not a requirement, but may generally serve as a guide.
AGI Data Sheet	CI < 40 An < 50	CI > 40 An > 50	Where criteria conflict, name selected by geological circumstances, convenience, and individual judgment.

Abbreviations: An - molecular percent anorthite in plagioclase.
CI - color index--volume percent of dark minerals.
plag - plagioclase

Figure 2. Criteria used by different authors to separate the diorite and gabbro clans.

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DEAR SIR,

As a Postdoctorate Fellow of the National Research Council of Canada and an Honorary Advanced Fellow of the Belgian American Educational Foundation, I have spent two years on the North American Continent working with the Geological Survey of Canada. Alas, every good thing has an end and I am going back to my country, Belgium, in a few days where I will resume my occupation as Sous-Directeur de Laboratoire at the Institut royal des Sciences naturelles, 31, rue Vautier, Brussels.

While here, I have been chiefly working on the Famennian faunas of Western Canada, that I had the privilege to study in the field as well as in the laboratory.

Working with the Geological survey of Canada has been a remarkable experience for me as this institution occupies a prominent place in the field of geological research. I am writing this short letter to you to express the wish that many more scientists from various parts of the world would be given the opportunity to work for an extended period in first class scientific institutions.

Yours sincerely,

PAUL SARTENAER

DEAR EDITOR:

We received the GeoTimes IV; 8, May-June from Prof. L. Miller of UCLA, because it contains Dr. Dubar's excellent essay on Leonardo's Geology. May I ask you to send a copy or a reprint to Raccolta Vinciana, Attn: Dr. Lorenzi, Castello Sforzesco, Milan, Italy.

Dr. Lorenzi is preparing the current Leonardo Bibliography to appear in the next yearbook, 1961. I promised to help him get important American publications. Thank you.

KATE STEINITZ,
Librarian
Elmer Belt Library of Vinciana
Los Angeles

DEAR EDITOR:

Technical papers presented at national conventions during the past several years are becoming so brief (generally 10 minutes) that the situation is ridiculous. Just recently at a National there were in excess of 350 papers programmed in 3 days. Such a limited presentation period does not do justice to the subject, the speaker, or the audience. I suggest that program chairmen in the future demand that a paper be ready for publication before it is accepted on a convention agenda. Also let's eliminate the philosophy, "If I give a paper someone will pick up the expense tab."

Sincerely,

L. W. LEROY,
Golden, Colo.

Research Participation for Teachers

The National Science Foundation recently announced awards totaling $1.3 million to colleges and universities to provide research participation opportunities to 350 college teachers of science and 310 high school teachers.

No awards among the 41 made to institutions for college teacher participation were made for research participation in the geological sciences.

Five of the 47 institutions receiving awards for research participation programs for high school science teachers extend to include research participation experience in the earth sciences. The schools involved are Cornell University, Rensselaer Polytechnic Institute, University of Oklahoma, State University of South Dakota and Brigham Young University.

Research Participation for Students

The National Science Foundation recently announced the awarding of 357 institutional grants through its Undergraduate Research Participation Program, for the year beginning in the summer of 1961. The purpose of the program is to help build interest of superior students in research, to widen their understanding of scientific methods and to improve their ability to employ scientific investigative procedures through the opportunity to work in cooperation with established scientists actively engaged in research.

The Foundation made available $3.2 million in support of the total program. Of the 357 programs 19 involve geology. Of the 19 involving geology 10 have been awarded to departments of geology, the remaining nine are interdisciplinary.

C. & G. SURVEY

(Continued from page 13)

positions and elevations of specific points on the earth's surface. The results of these measurements are used by engineers in many different fields for the development and conservation of our natural resources. The engineer assumes that monumented points remain fixed and may be used as reference points in extending surveys for his particular project.

The networks of geodetic control in the United States have increased in importance with each succeeding decade. To these networks have been tied all natural features such as mountains, rivers, coastlines, and land formations which in turn have been tied to the offshore control in the coastal waters, including the continental shelf areas of the Nation.

Seismologists and geologists have suggested to the geodesists that the same precise methods used in establishing fundamental surveys could be used for detecting small movements in the earth's crust. Except in the special case of an earthquake where there may be large horizontal and vertical displacements, the rate of movement in the earth's crust will be quite slow. If the differences of survey measurements are to be used to determine earth movement, the measurements should be made at widely spaced intervals of time. Generally a period of 10 years is assumed to be a reasonable interval. Horizontal and vertical movements are more rapid in a few places such as on Terminal Island in San Pedro Bay, California, where measurements made at six-month intervals have shown significant changes. However, the systematic movements which are taking place in the larger blocks of the earth's crust are much slower.

The Coast and Geodetic Survey has a program for systematically reobserving networks of horizontal and vertical control points in areas of known seismic activity. Most of these are in California along the major fault lines, particularly the San Andreas fault. There are some additional areas in Nevada and Montana where similar periodic measurements are being made. The results of these special surveys are published in various journals as the information is obtained.

Geodetic Measurements in Detecting Earth Movement

In that phase of geodesy involving the establishment of vertical control the work is not always of a routine nature. For instance, the effects of frost action in certain areas, and of freezing and thawing are especially critical. Where the slight heaving of a triangulation mark might create little damage to its geographic position, any measureable amount of heaving of a bench mark destroys its value as a precise yardstick of elevation.

The nature of these operations might be effectively revealed by experiences encountered by Bureau field parties operating in the Columbia River basin in support of water resources development. Some of these operations were the most arduous leveling field work ever accomplished in the history of surveying. In order to provide the required control, lines of levels were run through the desolate and dangerous canyons of the Snake, Salmon, Grande Ronde, John Day, and Deschutes Rivers. Many of these canyons were in rugged, isolated terrain creating many transportation problems. Connecting loops had to be carried over high mountains.

When a network of triangulation is reobserved and resulting coordinates of monumented points compared with coordinates from previous surveys, the small differences which are obtained may be due to the inevitable small errors of observation, questionable selection of fixed points from which to start comparable calculations, and finally, the phenomena being sought, that is, earth movement itself. The accuracy of observations can be controlled and by careful study and experience selected reference points may be considered as stable. Thus, it may be concluded that the differences indicate small systematic movements in the crust.

This method has been supplemented by reobserving at intervals of a few years astronomic azimuths of lines perpendicular to the fault zone. The changes in azimuth indicate the horizontal movement that has taken place. The remeasurement of the angles in a traverse line roughly perpendicular to the fault zone also gives an indication of movement, particularly when there is any small displacement or slippage along the fault. Rechecking of alignment points set perpendicular to the fault is a special application of this type of measurement.

In some regions such as those adjacent to the San Andreas fault where the earth's crust is being deformed in a very systematic manner, the reobservations of directions in a triangulation network may be used to compute the amount and rate of deformation. With the assumption that a small rectangular area near the fault line, the sides of which are parallel to the fault, is being deformed into a parallelogram by the major forces acting within the earth's crust, a comparison of two sets of direc-

tions of lines radiating from a single point within this area will determine the amount of deformation in a horizontal sense. Studies of this type that have been made in networks crossing the fault line have indicated that the rate of deformation is of the order of one to two seconds of arc per 10 years near the fault zone and one-half to one second of arc in areas 10 to 15 miles from the fault zone. A comparison of the total indicated movement between points 30 to 40 miles apart on opposite sides of the fault zone provide a rate of horizontal movement of one to two feet per 10 years. These amounts are in agreement with the angular quantities computed for the smaller areas near the fault itself.

Releveling of bench marks on lines of precise leveling across the San Andreas fault has been continued in a similar manner. The resurveys have not shown any large vertical movement as yet, the maximum divergence between levels being of the order of three to four centimeters.

An intensive program of releveling has been carried on in the San Joaquin Valley for settlement studies. One of the principal factors contributing to settlement in this area is the removal of underground water for irrigation. Also, the lava sediments in this valley show settlement because of the compaction of this type of soil when water is added in the process of irrigation. Many areas are known where the settlement during the last 25 years has exceeded 10 feet.

Terminal Island in San Pedro Bay, previously mentioned, is a unique case of the probable cause of settlement being the removal of oil and gas. The amount of settlement there during the past 30 years is of the order of 25 feet. At the same time there has been horizontal movement toward the point of maximum vertical movement.

In the California region it has been possible to anchor the relevelings to bench marks which may be considered as stable. In the Galveston-Houston area of Texas the Coast and Geodetic Survey has had a program of extensive releveling to determine the amount of subsidence. In this region the resurveys must extend outward for some distance until satisfactory checks are obtained on remeasurements between consecutive bench marks. Indications have been noted of settlement ranging from three to four feet in this region based upon measurements made during the past 20 years.

This broad program of resurveying for determining these small movements has been continued to the extent of available funds. In a few instances assistance has been given by other agencies which had a particular interest in the work. Time and human effort are required to collect the data needed in this very special application of geodetic surveying, for increasing our knowledge of the behavior of the forces within the earth's crust and the effect of these forces on the crust.

Geological Applications of Gravity Measurement

The force of gravity is measured for geologic as well as geodetic purposes. In geodesy, gravity investigations are concerned with the determination of astronomic positions; all astronomic observations depend upon the direction of gravity, which must be defined by very accurate spirit levels. Even though the observations are well referenced to the direction of gravity, they must also be referenced to the perpendicular, or normal, to the spheroid on which the triangulation is computed. The deflection of the vertical, determined by gravity observations, is the amount by which the plumb-bob line is deflected away from the true line to the center of the spheroid. This deflection is caused by the unequal mass distribution of the materials that form the earth.

In the middle eighteenth century Bouguer, a member of a French party engaged in geodetic measurement of a meridian arc in Peru, found that the observed deflections of the vertical were much less than the calculated attractions of the vertical mountain masses. Later investigations by Pratt, Airy and others beginning about 1855 established conclusively from geodetic data that mountains and ocean basins were underlain with compensating arrangements of density in the earth's crust. This important theory of isostatic compensation was further confirmed by measurements of the intensity of gravity on the earth's surface, after corrections were applied for elevation above sea level and for visible topography.

The measurement of gravity intensity is inherently a difficult physical problem because of the high accuracy required; for geodetic or geological purposes this accuracy must be maintained while operating over wide expanses of terrain or over water surfaces. The Coast and Geodetic Survey was a pioneer in the development of gravity instruments, the initial period from 1873 to 1891 being mainly one of research in the theory and practice of pendulums. These instruments were ultimately perfected to an accuracy of about one part in a million. When this degree of perfection was reached, an epoch began of operational gravity work which extended to the 1940's. At that time the Coast and Geodetic Survey had established a regional coverage of 1200

ROCK CHIPS

by SANDSTONE SAM

Ideas are like children—your own are wonderful.

* * *

Conference: A meeting at which people talk about what they should be doing.

* * *

Students write—

- *Features of glacial deposition are grumlins.*
- *Groundwater may cease to be groundwater by perspiration.*
- *Physical breakdown of rocks is disipation.*
- *Bathsalt flows from a volcano.*

* * *

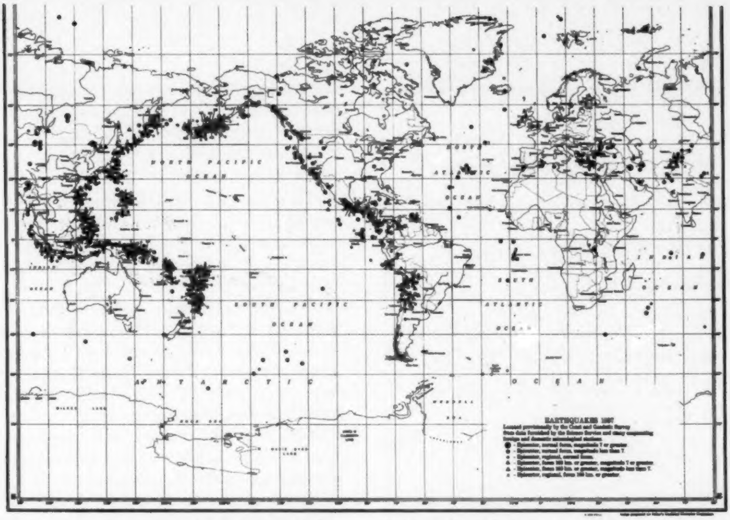
The easiest way for a driver to lose control of a car is to forget to make the payments.

pendulum stations throughout the United States. Meanwhile, the prime economic importance of opening up new sources of petroleum and minerals had led to the invention of static gravity meters that could measure gravity differences with a precision of nearly a hundred times that of pendulum instruments.

Since a gravity meter requires external control of calibration and datum, the Coast and Geodetic Survey system of described and marked pendulum stations played a vital role in controlling the mushrooming network of gravity meter surveys executed by prospecting organizations beginning about 1935. It is the nature of gravity meter surveys that they can be quite easily adjusted into a homogeneous system if each individual survey has been tied to a few readily recoverable points.

The Survey is now developing a nationwide system of gravity meter base stations. All measurements are made by short-range drift loops with a station precision approaching 0.1 milligal. The system originates at the mid-continent gravity traverse controlled in datum and calibration by six precise pendulum stations between Brownsville, Texas and Winnipeg, Manitoba. The mid-continent line is connected to traverses on the east and west coasts by direct aircraft gravity meter connections, with gravity differences not exceeding 70 milligals and indicated precision of about 0.1 milligal. As the new traverse nets are extended, all pendulum stations in the U. S. network are being recovered and more accurate gravity values determined for them; this is of special importance since the early prospecting surveys of high station density were tied to the pendulum stations.

Gravity meters can measure small gravity differences with extremely high accuracy, due to almost complete elimination of the calibration uncertainty; these differences can be measured over great distances, provided the time intervals are kept short. This principle was first applied on an extended scale in 1954 when the Coast and Geodetic Survey, in cooperation with Italian scientists, measured the gravity difference between points in New York and Rome, Italy by three round-trip air shipments of a set of four gravity meters. The difference was measured with a precision of 0.02 milligal, corresponding to a vertical station displacement of only two inches. Since that time several other east-west connections of this type have been made, across the United States and across the Atlantic Ocean. Periodic repetition is contemplated of these connections which will afford a



Earthquakes of 1957 located by the U. S. Coast and Geodetic Survey.

powerful new means of detecting relative vertical crustal movements of one foot or less.

During the past five years the Coast and Geodetic Survey has executed area gravity meter surveys over a considerable portion of the north-central United States, running generally northward from Kansas to the Canadian boundary in a belt about 400 miles wide. These area surveys are based on an average station spacing of six miles and, while primarily intended for geoid studies, also provide a satisfactory gravimetric picture of the regional geology. A most striking feature is the positive free-air anomaly of nearly 100 milligals amplitude extending northeastward from Nebraska through Iowa and Wisconsin.

Geologists are familiar with the importance of measuring gravity at sea in determining local density anomalies and studying the hydrostatic equilibrium of the earth's crust. Starting with the invention of a multiple pendulum apparatus by the Dutch geophysicist Vening Meinesz in the 1920's for operation in a submarine, instrumental developments have now progressed to a point where gravity meters can be operated over the open ocean in ships of a few thousand tons displacement.

Meters operated under these conditions require special devices for filtering out the sizable local accelerations encountered on the vessel; also it is necessary to maintain high accuracy in navigation so that the east-west component of the velocity of the vessel can be properly allowed for. Navigational procedures of Coast and Geodetic Survey hydrographic and oceanographic ships are especially well suited to these measurements, and ocean gravity operations will begin in early 1961 as a part of the expanded oceanographic program.

Seismological Processes in Geology

The Coast and Geodetic Survey is the official agency of the United States for studying and analyzing earthquakes for both utilitarian and purely scientific purposes. An earthquake can be a devastating natural calamity. The sudden release of accumulated strain energy along deep-seated fault zones annually causes loss of life and property. The first task of the seismologist is the location of earthquakes which requires the cooperation of hundreds of stations.

The Coast and Geodetic Survey is recognized as a world leader in this phase of geophysical science. Data sent in from seismologists all over the world are used by the Survey to locate about 1400 earthquakes a year within a few days after they occur. These data are supplemented by the interpretation of the records from 24 stations maintained by the Coast and Geodetic Survey in the United States, Guam, Greenland and Antarctica.

In the past twelve months disasters in Agadir, Morocco, Lar, Iran, and in southern Chile, costing approximately 17,000 lives and three-quarters of a billion dollars, have dramatized this devastating force of Nature. These rather frequent occurrences emphasize the need for comprehensive study of earthquakes to minimize the loss of lives and property. Data made available to structural engineers are of increasing importance in structural designing in high seismicity areas. Advance warning of seismic sea waves is another eminently practical application of seismological data. In recent years precise surveys have been made of earth

movement resulting from underground explosion tests. Data thus obtained are used to study the effects of potential bombings or guided missile attacks upon surface and subsurface structures.

The results obtained from the Survey's work in seismology contribute to the geologic concept of the earth and earth processes in several general areas. First, seismology as the study of earthquakes presents the geologist with a synoptic view of the earth as it reacts to elastic waves. Elastic waves from earthquakes reach all depths of the earth and provide the most direct information available for the earth beyond the reach of the exploration drill. The minute vibration of the earth's surface caused by the passage of these elastic waves is recorded on sensitive instruments, some of which have magnifications of half a million. The interpretation and analysis of these records called seismograms provide information on the layered structure of the deep interior of the earth and on the physical parameters of density, rigidity and bulk modulus.

The earth model built from seismic evidence consists of a solid inner core, a liquid outer core, a solid mantle with several minor discontinuities, and a thin crust. Geologic theories of the genesis, evolution, composition and geodynamic processes of the earth are governed in part by the seismic model and physical parameters defined by the velocities of seismic waves.

Currently a new technique has been developed by the Coast and Geodetic Survey which employs modern high-speed electronic computers to locate earthquakes with greater accuracy than by the graphical methods previously used. With the earthquakes epicenters known, seismologists use the data from their seismograms for studies of crustal thickness which show it to be about 60 kilometers under young mountains and 10 kilometers under the oceans. These data are also used for determination of the direction of motion of deep-seated faults, now known to be predominantly transcurrent, and for seismicity studies.

A second area of interest to geologists is the association of earthquakes with orogenic belts as a clue to the processes which have given rise to the structures now observed on the surface. Epicenters plotted on maps show that the distribution of earthquakes is not random. Most earthquakes occur in three belts—the circum-Pacific belt which rings the stable Pacific Ocean basin and which accounts for nearly 90 per cent of all major earthquakes and almost all earthquakes deeper than 300 kilometers; the

Alpide belt which reaches from the Atlas mountains through the Himalaya mountains, and Indonesia terminating at New Guinea; and the Atlantic-Arctic belt.

Areas of high seismicity are characterized by towering topographic relief. In coastal or inland regions rugged terrain with substantial elevations may be accentuated by narrow continental shelves or oceanic trenches. The circum-Pacific belt is characterized by a series of arcs. Typically the depth of earthquakes increases on the concave side of the arcs indicating a fault zone dipping about 45° under the arc toward the landward side.

Small earthquakes occur even in the stable parts of the earth. In the United States these small earthquakes are canvassed by mail and areas of equal intensity are contoured. These contours are not regular but reflect the effects of surface and basement structures in the transmission of elastic waves. These small earthquakes appear to occur in lineations which divide the stable area into a black mosaic.

Faulting which causes earthquakes in stable areas may not reach the surface but may have an expression in the basement structure which is reflected in the surface geology. Some faults are seismically quiet such as the Llano uplift in Texas, while others such as the Nemaha and Amarillo uplifts are active. These earthquakes may be adjustments to the tectonic movements in the major belts.

The Yellowstone earthquake of 1959 offered an opportunity for intensive field investigation of a major United States earthquake. Intensive investigations of this type provide for remeasurement of geodetic nets. Data thus obtained reveal changes in elevations and distortion caused by an earthquake which may not be noticeable to the eye. In agreement with the elastic rebound theory, periodic geodetic remeasurements across active faults detect the relative movements of the two sides of the fault. Such measurements provide the most hopeful approach to predicting the occurrence of an earthquake. Many geomorphic features such as the San Andreas rift and the Basin and Range province have their origin in fault movements which are still active.

The Coast and Geodetic Survey is participating in a national program to encourage the conduct and expansion of fundamental research in seismology. To initiate one phase of this program the Survey will instrument approximately 125 stations in all areas of the world. The objective is to provide standardized instrumentation capable of furnishing quantitative data for the studies of world seismicity, earthquake mechanism, seismic wave propagation and energy determinations. The new instruments will be capable of recording seismic waves over a wide range of periods (about 0.1 to 100 seconds). They will be accurately calibrated, and the response characteristics will be identical at each station. The intent is to establish a cooperative world-wide seismographic net employing standardized equipment in addition to, or in place of, the existing seismographs.

Conclusion

Coast and Geodetic Survey contributions to the science of geology, as well as other branches of scientific endeavor, fall into three classifications: (1) The collection and dissemination of basic physical data essential to scientific investigations; (2) By-products of Bureau operations for utilitarian purposes; and (3) Contributions emanating from the use of scientific methods in the work whose development from time to time brings unexpected additions to scientific knowledge.

Perhaps the most important aspect of the Survey's 153 years of service to the Nation has been the unceasing adherence to high standards of precision and accuracy. The vast areas with which the Survey has been concerned are a considerable portion of the earth's surface. The application of scientific methods with the highest degree of integrity and faithfulness to detail is in itself a contribution to science. This fact is especially impressive when it is considered that a very large part of the earth will probably never receive such detailed examination.

STANFORD LECTURE SERIES

The School of Mineral Sciences at Stanford University sponsored a lecture series on the general subject *The Earth Sciences, Their Value Today* during January and February. Guest lecturers participating in the 1961 program were Richard R. Doell, Gordon A. Macdonald, Edgar W. Owen, Edwin B. Eckel, Charles L. Drake, and Roger Rhoades. The lecture program, developed by Harold W. Hoots, consulting professor, was open to the general public.

SLIDE MANUAL: A GUIDE TO THE PREPARATION AND USE OF PROJECTION SLIDES, *William R. Moran, Elmer W. Ellsworth, Carl A. Moore, and L. L. Sloss, 28 pp., 1960, American Assoc. of Petroleum Geologists, P.O. Box 979, Tulsa 1, Oklahoma, $1.25.*

This booklet is an excellent compendium to guide in the preparation and projection of slides and transparencies. The presentation of the information is superb. Religious adherence to the specs and tips set forth in this booklet would avoid the reactions of embarrassment, frustration and disgust that beset speakers and audiences when poorly executed and/or poorly projected illustrations are flashed on the screen. The manual will find wide acceptance by all who prepare slides. The work of John E. Asher in design, layout and production of the manual is particularly outstanding.

DIE ERZMINERALIEN UND IHRE VERWACHSUNGEN *by Paul Ramdohr, Akademie-Verlag, 1100 pp., 3rd edition, about $26.00 U. S.*

A thoroughly revised edition with numerous additions, in particular on the uranium minerals. The only complete reference book of its kind and at the same time a complete "Mineralogy of the Ore Minerals." The first, introductory part can serve as a textbook on the Geology of Mineral Deposits.

G. C.

PALEOGEOLOGIC MAPS, *by A. I. Levorsen, 174 pp., 1960, W. H. Freeman & Co., 660 Market St., San Francisco 4, Calif., $6.00.*

Discusses the concepts of paleogeologic maps, how they are developed and how they may be utilized in the interpretation of geological history and in the solution to problems of applied geology. Numerous examples are shown. This book is one to make geologists think and perhaps debate.

INVERTEBRATE PALEONTOLOGY, *by William H. Easton, 701 pp., 1960, Harper & Brothers, 49 East 33rd St., New York 16, N. Y. $10.00.*

This newest edition to the Harpers Geo-Science Series, edited by Carey Croneis is a somewhat more sophisticated textbook in paleontology aimed at filling the void between elementary texts and the comprehen-

sive reference volumes. A noteworthy feature is the question section appearing at the end of each chapter. The book is well documented with references.

MANUAL OF PHOTOGRAMMETRIC INTERPRETATION, *868 pp., 1960, American Society of Photogrammetry, 1515 Massachusetts Ave. N. W., Washington 5, D. C. $12.00 (non-members), $10.50 (ASP members).*

This most complete manual on photogrammetry will be helpful to geologists in many respects. The book deals not only with the basic elements of aerial photo interpretation, but contains 128 pages of text on photo interpretation in geology and 45 pages of references on photogeology as well as similar sections on soils, agriculture, forestry, wildlife management, engineering and geography, etc.

DIRECTORY OF UNIVERSITY RESEARCH BUREAUS AND INSTITUTES, *208 pp., 1960, Gale Research Co., $20.00.*

Contains about 1500 listings of academic-connected organizations carrying on continuing programs of research.

HANDBOOK OF CHEMISTRY & PHYSICS, 42ND EDITION, *C. D. Hodgman editor-in-chief, 3481 pp., 1960, Chemical Rubber Co., 2310 Superior Ave., N.E., Cleveland, Ohio, $12.00.*

This standard reference volume continues to expand as new physical and chemical data become available.

CRYSTAL-STRUCTURE ANALYSIS, *by Martin J. Buerger, 668 pp., 1960, John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., $18.50.*

A thorough treatise on the subject of crystal-structure analysis for research workers and advanced students in this field.

MINERAL ECONOMICS AND THE PROBLEM OF EQUITABLE TAXATION, *by Oscar H. Lentz, 111 pp., 1960, Colo. School of Mines Quarterly Vol. 55, no. 2, Colorado School of Mines, Golden, Colo., $1.00.*

A study in the legislative rationale of percentage depletion allowances which concludes that they ". . . are not mere loopholes of tax avoidance. In principle, percentage depletion allowances are eminently sound. Consequently percentage depletion allowances should be retained in our federal income tax system."

NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES, *10th Annual Report, 100 pp., 1961, Geological Survey of Canada, Dept. of Mines and Technical Surveys, Ottawa, Ontario, $0.50.*

Includes Survey of current research in the geological sciences in Canada, 1959-60.

High School Teacher Workshop. Earth Science teachers of Rochester and Monroe County, New York, are pictured at Ward's Natural Science Establishment on December 13, 1960, at the first of a new series of Science Teachers' Workshops. An initial series of workshops held early in 1960 had provided information and assistance to high school biology teachers. These workshops proved so popular that a second program was planned for the winter of 1960-61, and a new series for earth science teachers was added. These workshops by Ward's Natural Science Establishment, well-known commercial supplier of geological specimens and equipment, are an interesting example of cooperation between private industry and public schools for a mutual exchange of information. Teachers attending the workshops receive lectures, demonstrations, and practical work in various methods, materials, and techniques of natural science teaching; in return, Ward's receives valuable suggestions for the improvement and development of teaching aids. The workshops were the outcome of a conference last year. David E. Jensen, Head of Ward's Geology Division, is in charge of the earth science program.

Soviet Geochemist Smirnov Visits U. S.

Vladimir I. Smirnov, noted Russian economic geologist and specialist in the field of the geochemistry of ore deposits, visited in the United States during January and February under the auspices of the exchange agreement between the National Academy of Sciences—National Research Council and the Academy of Sciences of the U.S.S.R. Dr. Smirnov visited various academic institutions and research centers of the U. S. Geological Survey engaged in geochemical investigation of ore deposits. His trip was arranged by the Office of International Relations of the Academy.

Popular Geology in print

by Mark W. Pangborn, Jr.

Anyone interested in the history of petroleum will enjoy the thoroughly-researched BEARSTED, A BIOGRAPHY OF MARCUS SAMUEL, by British novelist *Robert Henriques* (Viking, 1960, $7.50), who reviews the life of the British-Jewish oil pioneer, and traces the ups and downs of his "Shell" tanker firm from its beginnings in 1892, through its absorption by Royal Dutch in 1907, to Samuel's death in 1927; bibliographical notes. Less satisfactory is *Ralph Hewin's* THE RICHEST AMERICAN, J. PAUL GETTY (Dutton, 1960, $5), about the publicity-shy financier and boss of the Getty-Tidewater-Skelly oil empire; Getty is no heroic figure, and Hewin's namby-pamby style flattens him still further.

THE FIRST BIG OIL HUNT: VENEZUELA 1911-1916 (Vantage, 1960, $10) is a compilation of the reminiscences of *Ralph Arnold* and a score of other geologists who pioneered the opening of one of the greatest of oil fields; despite the abundance of pictures, the "cut-and-paste" nature of this volume may limit its interest to the professional. Oil man, librarian, and layman alike will find *E. B. Swanson's* A CENTURY OF OIL AND GAS IN BOOKS (Appleton, 1960, $4.50) a quite indispensible starter in any research; some 2000 books in English are listed, arranged by subject and annotated, with index.

The subject matter in solid earth geophysics is so unfamiliar that one might expect any layman's book on this topic to be built around an abundance of carefully conceived diagrams; such is seldom the case. Anthropologist *Charles H. Hapgood,* of "Earth's shifting crust" fame, has turned out a clearly-written GREAT MYSTERIES OF THE EARTH (Putnam, 1960, $2.50) for ages 8 to 12, in which he touches on such subjects as the earth's origin and age, the origin of continents, volcanoes and mountains, ice ages, shifting poles and relict magnetism; alas, the pictures are far less informative than the text. EXPLORING UNDER THE EARTH, by *Roy A. Gallant* (Garden City Books, 1960, $2.95), covers the same topics for ages 10 to 14; the text is reasonably accurate where the author paraphrases authorities, but the numerous illustrations vary greatly as to quality and suitability. THE MYSTERIOUS EARTH (Chilton, 1960, $2.95), apparently aimed at teen agers by science-fiction writer *Lester del Rey,* is notable mainly for its complete lack of illustrations.

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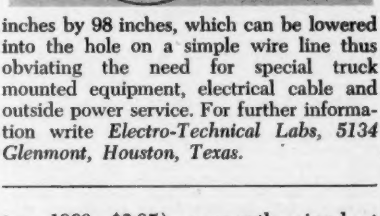

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VACANCIES

GEOPHYSICIST-OCEANOGRAPHER. Ph.D. or equivalent interested in developing geophysical program at new, rapidly expanding marine laboratory of West Coast university. Desire researcher interested in underwater sound, seismicity, and/or gravity. Box 127.

GEOLOGICAL ENGINEER. To teach courses covering applications of geology and engineering to construction projects and to exploitation of mineral deposits. Share introductory courses and take responsibility for engineering geology, geophysics, mining, and mineral dressing. Research encouraged. Ph.D. with practical experience preferred; mining engineer or master's level considered. Rank and salary dependent on qualifications. Department of Mineral Industries, North Carolina State College, Raleigh, North Carolina.

DEPARTMENT OF GEOPHYSICS. University of Western Ontario, London, Canada. Applications are invited for the position of Lecturer or Assistant Professor. Applicants should possess a Ph.D. or equivalent. Inquiries are also invited from persons wanting to carry out graduate research leading to a higher degree. Facilities are available for research in Terrestrial Heat Flow, Seismology, High Pressure Phenomena, Rock Magnetism, Nuclear Geology, Gravitation, Exploration Geophysics. Lists will be closed on March 31, 1961 or when the positions are filled, whichever is the earlier. Inquiries should be addressed to the Head of the Department.

UNIVERSITY OF WESTERN ONTARIO, LONDON, CANADA: NRC post doctoral research fellowship with preference for structural geology but other fields considered if candidate has satisfactory qualifications. Stipend is $4000 single, $5000 married, tax free, plus travel and generous equipment allowance. Application blanks, and information from Chairman, Geology Department. Closing date May 1, 1961.

Applications from candidates for graduate degrees also received until April 1.

GEOLOGISTS—Four positions available to teach in the fields of Mineralogy, Petrology, Petrograph, Paleontology, Stratigraphy, Structural Geology, Economic Geology and Geophysics. Good opportunities for research. Adequate salary. Two year contract, renewable. Inquiries with complete credentials to Escola De Geologia —Universidade Da Bahia—Salvador—Bahia—Brasil—Courses in Portuguese, Spanish, English or French.

GEOLOGY TEACHER for one year contract to teach undergraduate courses in Mineralogy, Petrography, and Petrology. Write to Prof. James S. Yoiton, Chairman, Geology Department, Upsala College, East Orange, New Jersey.

CHEMISTRY AND MATHEMATICS INSTRUCTOR with Master's degree and sufficient training to teach General Chemistry and first two years of college Mathematics in a small liberal arts Junior College in New England. Small classes. Fringe benefits. Salary adjusted to experience. Send transcripts and three references. Box 128.

ACADEMIC POSITION open for geologist with broad scientific background, to teach geology and Freshman Science courses, and to assist in the development of a degree program for geology majors. Northeastern U. S. Box 129.

PETROGRAPHER for x-ray and microscopy section. Must be experienced in the use of the petrographic microscope. Experience with electron miscroscope desirable but not essential. Research will include polymers and inorganic materials. Send resume to: Dr. David M. Clark, W. R. Grace & Co., Research Division, Washington Research Center, Clarksville, Maryland.

STRATIGRAPHER—ECONOMIC GEOLOGIST, Ph.D. To undertake geological studies of nonmetallic industrial minerals. State Survey. Salary dependent on qualifications and experience. Prefer young man. Box 130.

NORTHERN ILLINOIS UNIVERSITY. DeKalb, Illinois. New Professorship in Mineralogy, to start September 1961. Doctors degree, graduate-level teaching, research, and research advising on doctoral level required. Monthly starting salary about $900.00-$1,100.00 Chairmanship of to-be-formed Geology department possible within two to four years. Candidates academic records, letters of application and recommendation may be sent to Dr. Loren T. Caldwell, Head—Department of Earth Sciences, N.I.U., DeKalb, Ill.

POSITIONS WANTED

BOX 748. EXPLORATION GEOLOGIST, Ph.D. Degrees in mining engineering and geology. 10 years field work with Canadian Geological Survey and Quebec Department of Mines. Teaching experience in physics and geology. Publications, physics and geology. Professional engineer. Six years geologic exploration in Venezuela and Brazil. Desires foreign work.

BOX 768. GEOLOGIST-MINERALOGIST, Ph.D., 31, family. Three years experience in major oil company research laboratory in fields of X-ray and fluorescence analysis, clay mineralogy and geochemistry of sediments. Broad graduate background in geology. Desires position at college or university. Available immediately.

BOX 769. PETROLEUM GEOLOGIST-STRATIGRAPHER, 33, M.S., family, 8 years varied experience in teaching, exploration, research and consulting, Texas, Mid-Cont., Appalachians & Rockies. Desire a responsible position in exploration or basin studies. Have supervisory experience. Will consider any position. Resume sent upon request.

BOX 774. GROUND WATER GEOLOGIST-HYDROLOGIST, 40, family. 1 year post graduate work. Five years experience with USGS, five years consulting. Geohydrology and engineering background with experience throughout U. S. Interested in position of responsibility. Open to foreign work. Resume on request.

BOX 776. PALEONTOLOGIST-STRATIGRAPHER, 40, M.S., Ph.D. expected '61. Desires teaching position with opportunity for research. 14 yrs. college teaching experience in paleontology, stratigraphy, sedimentology, historical, physical and petroleum geology and related fields. Experience includes state survey work. Publications.

BOX 786. GEOLOGIST, nine years experience in the Four Corners, Panhandle and West Texas. Broad exploratory background includes sub-surface, administration and seismograph. Some field and well work. Desires more responsibility.

BOX 787. GEOLOGIST, Ph.D. Desires teaching and research position in University in SEDIMENTARY PETROLOGY, STRATIGRAPHY (Principles), and SEDIMENTATION. Can also teach Regional Stratigraphy, Regional Geology, Historical Geology, Invertebrate Paleontology, Hand-specimen Petrology, Structural Geology, Geomorphology or Pleistocene Geology. Special interests include sedimentary rock petrogenesis, sedimentary structures and paleo-currents. Previous teaching experience at elementary and senior level. Field experience in North America and Europe. Location preferred: Northeast US, North-central US, Northern Rocky Mountains, Pacific Northwest and Canada. Currently employed.

POSITIONS WANTED—Continued

BOX 788. TEACHING. Structural geologist with interest in economic and allied fields and 15 years experience in teaching, industry, and government wants position at college or university.

BOX 789. GEOLOGIST, Ph.D. (1952) desires teaching position; morphological and optical crystallography, mineralogy, petrology, petrography and/or structural, regional, and historical geology. Over ten years teaching experience, mainly in large institutions; small or medium-sized college preferred.

BOX 790. ECONOMIC GEOLOGIST with engineering geology experience. Would like university position in strong Geology Department. Ph.D. with thirteen years international experience. Available in Sept.

BOX 792. GEOLOGIST, 25, single, European education, fluent English, French, German, Dutch. 2½ yrs. Canadian experience government surveys, copper-and asbestos exploration. Excellent references, resume on request. Main interests: structural geology, petrology. Desires seasonal or permanent employment with Canadian company or survey. Opportunity for research toward Ph.D. thesis appreciated. Available for interview and appointment May 1961.

BOX 793. GEOLOGIST-GEOPHYSICIST, 31, Ph.D. geology, M.S. physics, desires industrial or teaching position with research opportunities, preferably in Western U. S. or Canada. Qualifications include research and field experience in exploration geophysics, ore deposits, igneous and metamorphic petrology, and structural geology; two years as electronics technician; some teaching experience in geology, physics, methematics. Recently completed N.S.F. research followship in volcanology. Currently geologist for university Antarctic expedition; available June 1961.

BOX 794. MINING GEOLOGIST-PETROLOGIST, M.S. in Mining Geology. Age 28. Married, family. Experienced in X-Ray, D.T.A., and petrographic techniques. 3 yrs. with major company. Desires teaching or research position with University in Western U. S. offering Ph.D. program in geology. Will consider any type financial aid.

BOX 795. ASSISTANT PROFESSOR, 34, Ph.D. 7 yrs. teaching experience, 2 yrs. major oil company, desires to relocate. Main fields are invertebrate paleontology, sedimentology, stratigraphy, and structural geology. Has also taught petrology, optical mineralogy, and field geology. Summers have been spent mapping for a state survey. Resume on request.

BOX 796. ASST. PROF. Ph.D. Isolated State University wishes to teach in college or university in more desirable locale. Active researcher, Member professional societies, Bilingual, 5 yrs. varied governmental and industrial experience, 4 years teaching experience. Resume on request.

BOX 797. PETROLEUM GEOLOGIST, B.Sc., 33, family, 10 yrs. experience with major oil company as land surveyor and subsurface geologist. Geological experience mainly in Rocky Mountains and Western Canada. Desires employment as exploration or exploitation geologist in Rocky Mountains. Resume on request.

BOX 799. GEOPHYSICIST, 15 years experience exploration geophysics in U. S., Venezuela, Brazil and Libya. Broad background seismic techniques, experimental and production field operations, interpretation and evaluation of results in terms of geological objectives. Presently senior staff geophysicist, excellent references. Desires responsible position domestic or foreign.

BOX 800. GEOLOGIST/SOIL SCIENTIST. B.S. Soils 1948, B.A. Geology 1960, experience—2 yrs. teaching general agriculture, 10 years soil classification and survey with U.S.D.A. Prefer field work but will consider any challenging position.

BOX 801. MINING-EXPLORATION GEOLOGIST, M.A., 28, single. Presently completing a two year developmental project connected with a large ore deposit in West Africa. Previous geological position in the southwestern states. Desires to continue career in Africa.

BOX 803. RESEARCH GEOLOGIST, 31, 5 years industrial, teaching, research, consulting experience. Publications (stratigraphy, economic, structure, sedimentation) attest to drive, ambition, optimistic thought pattern necessary to recognize, organize, and successfully complete diverse assignments. Desire association doing basic research/evaluation on any level, i.e., industrial, survey, academic. Salary of least concern. Presently employed.

BOX 804. GEOLOGIST Single, 28, trilingual, M.Sc., leaning towards geophysics, working in oceanography and electronics, would like to be placed in field exploration. No limitations on travel.

GEOPHYSICIST, M.S., mining engineer, Ph.D. level geology. Broad physics and maths. background. 26 years worldwide experience in petroleum exploration and geophysical research. Languages: German, French, Spanish, Dutch, English. Seeks employment in research or petroleum exploration. P. O. Box 521, Oklahoma City, Okla.

BOX 805. PALEONTOLOGIST, Ph.D., 33, active specialist in lower macro-invertebrates with broad knowledge of geology and biology, 12 years of college teaching experience, also museum and field experience. Seeks position in museum, geological survey or university. Resume on request.

BOX 806. GEOLOGIST, Ph.D., broad background in Petrology and Geophysics. Age 39, married, no family. Fluent French, German, knowledge of Spanish. Formerly Chief Geologist. Wide experience in geological and mining exploration. Publications on mineral resources, photogeology, strüctural geology. Experience in teaching. Desires permanent industrial or University position.

BOX 807. BIOSTRATIGRAPHER — PALEOECOLOGIST. Geologist with special training and experience in the sedimentary rocks. Facility in the use of all tools applicable to the art and science of stratigraphic geology. Thorough academic grounding combined with 8 years in research and industrial operations in variety of basins. Knowledge and experience can quickly be applied to any area. Skills include paleontology, palynology, carbonate studies, petrology, clay minerals, chemical and optical techniques. M.S., age 33.

BOX 808. WANTED: Employment with firm willing to try new ideas. Position should have responsibility, commensurate authority, and promise of appropriate rewards for performance. Fringe benefits, security programs and the like are no inducement. Have A.B. with high honors, A.M., Ph.D., 12 years' experience in petroleum exploration, administration, field and laboratory research, and teaching. Aged 38, married, 2 children. Familiar with advanced quantitative methods in stratigraphy, paleontology and paleoecology. Numerous publications in structure, stratigraphy, paleontology and statistical methods.

BOX 809. GEOLOGIST, B.A., 10½ yrs. experience oil exploration Arabia Libya, recon and detail surface, subsurface, some photogeology, hydrology and administration, single. Desire position foreign or U.S.

ENGINEERING GEOLOGIST, B.A.—Geol., M.S. —Eng. Geol., Age 32, married, 8 yr. exp. in water, geophysics and soils; J. Edwin Garrison, 434 William Dr., Brownsburg, Indiana.

BOX 810. WELL-SITE GEOLOGIST, 24, M.Sc., bachelor, desires job in any oil exploration co. Ready to serve anywhere on the globe. Well trained in stanvac in sub-surface geology. Three yrs. experience with oil and natural gas commission in well-site techniques. Well acquainted with electric log interpretation, modern method of stratigraphic analysis, and sedimentation. Interested in sub-surface correlation and basin studies. Three years contract. Available immediately.

POSITIONS WANTED *(continued)*

BOX 811. GEOLOGIST, 28, single, East Indian, Ph.D., '59, major mid-western university. Desire college or university teaching position. Present research in structural geology. Substantial publication. Fields of interest, structural geology, economic geology, petrology and petrography. Available in September, 1961.

BOX 812. SEISMOLOGIST; Jr. Party Chief: A.B. Geol. 9 yrs. experience in Colombia, Venezuela, Brazil and the western U.S. Familiar with all phases of seismic exploration.

BOX 813. COLLEGE TEACHER, degrees major univ's. Desire to teach general courses in geology or oceanogr.; special work in sedimentation, stratigr., micropaleontology and marine geology.

BOX 814. EXPLORATION GEOLOGIST, B.S., LIB, 40, experienced, successful, principally metallic ores, also non-metallics, petroleum. Organize and/or manage ore-, raw materials-, or capital gains—finding program including negotiation, geologic, geochemical, and geophysical field work, drilling, valuation. Offer self-starting, creative leadership in exchange for aggressive backing.

BOX 815. STRATIGRAPHER-PETROLEUM GEOLOGIST, Ph.D., age early 40s, married, family, 15 years experience economic and academic. Experienced throughout major petroleum provinces and actual familiarity with West Coast Tertiary, Gulf Coastal Plain, Rocky Mountains and Appalachians (limited). Strong geography minor. Interested in responsible teaching position, especially foreign employment.

BOX 816. GEOLOGIST, M.A., Ph.D., Spring, 1961, 41, married. Three years part time teaching in major university (general, historical and structural geology) and ten years broad and varied domestic and foreign experience in petroleum geology including stratigraphic and structural investigations of continental scope. Desires stimulating teaching position with opportunity for research or imaginative research position in industry.

BOX 817. GEOLOGIST-PALEONTOLOGIST. B.S., 32, family. 8 yrs. experience in the West Texas, Texas Panhandle, and Four Corners Areas. Background includes subsurface geology, micro-paleontology and administration. Desires responsible position, domestic or foreign. Alert and willing to work to obtain such a position. Resume sent upon request.

BOX 818. GEOLOGIST-PALEONTOLOGIST, Ph.D., age 43, family, currently in temporary one year vacancy in major eastern university. Varied experience both commercial and academic. Courses taught include Field Principles, Regional Stratigraphy, Invertebrate Paleontology, Micro-paleontology and Sedimentation at both graduate and undergraduate level. Seek responsible teaching position.

BOX 819. GEOLOGY ENROLLMENT HAS BECOME MICROSCOPIC. Therefore, Geology Professor seeks other employment. Biostratigrapher, Ph.D., 35, family. Four years petroleum exploration and 4 years teaching experience. Will consider other teaching or industry position. Excellent references. Available this summer.

GEOLOGIST, B.S. Univ. of Texas, June, 1957. Mud logging on wildcats in Texas, New Mexico, Utah, Oklahoma, and Colorado, since separation from two years active Army duty, Sept. 1959. Summer work while in school included computer on seis crew, and work in Texas oil fields. Age 25 years, single, and no reservations on travel, foreign or domestic. Interested in any venture, petroleum or others. Resume, records, references, etc., furnished on request. Contact Jack S. Sanders, 524 W. Owing St., Denison, Texas.

CONSULTANTS

EFFECTIVE MARCH 1, 1961, Dr. Wolf Mayne has resigned his position with the Compagnie d'Exploration Petroliere, Chambourcy and Paris, as Research geologist, Supervisor of the Geological Laboratory, and Consultant. After 25 yrs. of activities in foreign countries with different oil companies, he will open an office of his own in Berne, Switzerland, to engage then entirely in consulting work (micropaleontology, stratigraphy).

J. W. SCHROEDER, PETROLEUM GEOLOGIST, P. O. Box 275, Cornavin, Geneva, Switzerland.

A. McGUGAN, GEOLOGIST-STRATIGRAPHER specializing in paleontology and micropaleontology, P. O. Box 672, Calgary Alta., Canada.

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"THE MINERALOGIST" is a magazine for the serious mineral collector and amateur mineralogist. Bimonthly, only $2.00 per year. Sample 25¢. Mineralogist, Box 808, Mentone, Calif.

Answer to Geologic Quiz

White Pine County, Nevada. From "Geologic Map of the White Pine District" published by the Nevada Bureau of Mines in their Bulletin 57.

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FIELD TRIP CALENDAR

(continued from page 4)

May 12-13—SEPM-SAN JOAQUIN GEOL. SOC., trip to San Joaquin Valley in so. part of Kern Co. to study Tertiary rocks of so. part of Valley. Write: Richard Pierce, Box 147, Bakersfield, Calif. Guidebook.

May 13—SEPM-GULF COAST SECT., trip to Houston, Cherokee and Nacogdoches Co's. to study type localities of Cook Mtn., Crockett, Weches and Reklaw Eocene fms. Write: Richard P. Zinguia, Box 2180, Houston 1. Guidebook.

May 20—ILLINOIS STATE GEOL. SURV., trip to Mazon Creek and Braidwood plant fossil collecting areas, quarries and outcrops of Morris area, Grundy County, Ill.

May 20-21—EASTERN FRIENDS OF PLEISTOCENE, trip to SW Maine to study Late Pleistocene and marine stratigraphy. Write: Arthur L. Bloom, Cornell Univ., Ithaca, N.Y.

May ??—MIDWESTERN FRIENDS OF PLEISTOCENE, no data available except that trip is to be conducted. Write C. P. Gravener, Geol. Div., Research Council of Alberta, Edmonton.

June 8-10—BILLINGS GEOL. SOC., a float trip in inflatable rafts down Big Horn Canyon prior to flooding by Yellowstone River dam to study Cretaceous to Cambrian in Canyon. Write: L. T. Hart, Box 318, Billings, Mont.

Late July—WYOMING GEOL. ASSOC., trip to E. flank of Rock Springs Uplift across to Powder R. Basin to study U. Cretaceous to L. Tertiary. Write: Fred Scheerer, Box 520, Casper, Wyo. Guidebook.

Aug. 25-26 — FRIENDS OF THE PLEISTOCENE, Rocky Mountain Section, 7th Ann. Field Conf., Bear Lake-American Falls, Ida. Write for inf. and reservations: J. Stewart Williams, Utah State U., Logan.

Sept. 7-8—ROCKY MOUNTAIN ASSOC. OF GEOLOGISTS, field conf. to study pre-Pennsylvanian section in Salida, Monarch, Ouray, Silverton and Durango areas. Technical session in Salida night of Sept. 6. Write: Conf. chairman D. W. Bergman, 315 Colorado Bldg., Denver, Colo. Guidebook.

Sept. 7-9—ALBERTA SOC. PETROL. GEOL., trip to Turner Valley, Savannah Creek and Kananaskis Lakes, southwest Calgary foothills and mountains to study mountain structures and Paleozoic and Mesozoic stratig. Write: H. G. Gammell, 528 9th Ave., W., Calgary, Alta. Guidebook.

Oct. 6-8—NEW MEXICO GEOL. SOC., trip to Sandia Mtns., Hagan Basin, Jemez Mtns. in SE San Juan Basin and Lucero Uplift to study geology of Albuquerque area. Write: Charles Reed, USGS, Box 4083, Albuquerque. Guidebook.

Oct. 7—UTAH GEOL. SOC., trip to Bingham mining district and adjacent Oquirrh Mtns. to study stratig. and struct. of district and mountains. Write: Douglas R. Cook, 1935 S. Main St., Salt Lake City. Guidebook.

Oct. 18-21—WEST TEXAS GEOL. SOC., trip to Coke, Nolan, Fisher and Stonewall Co's. Texas to study Permian stratig. and oil fields of the area. Write: Martin L. Johnson, Box 1540, Midland, Texas. Guidebook.

October—TRI-STATE GEOL. FIELD CONF., a trip will be conducted, but no details available. Write: Stanley Harris, Dept. Geol., Southern Illinois Univ., Carbondale, Ill.

October—ASSOC. OF MISSOURI GEOL., trip to St. Francois Mtns. of Ozark Uplift to study Precambrian and engineering geology. Write: W. C. Hayes, Mo. Geol. Surv., Box 250, Rolla, Mo. Guidebook.

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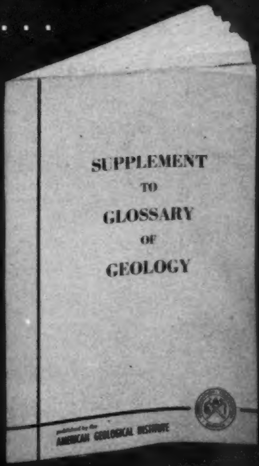

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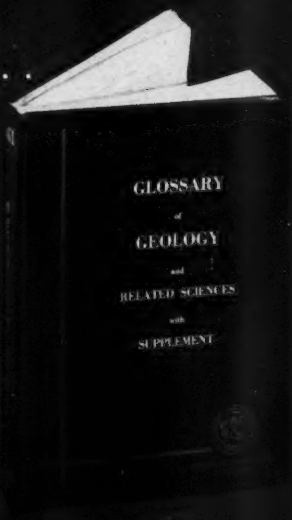

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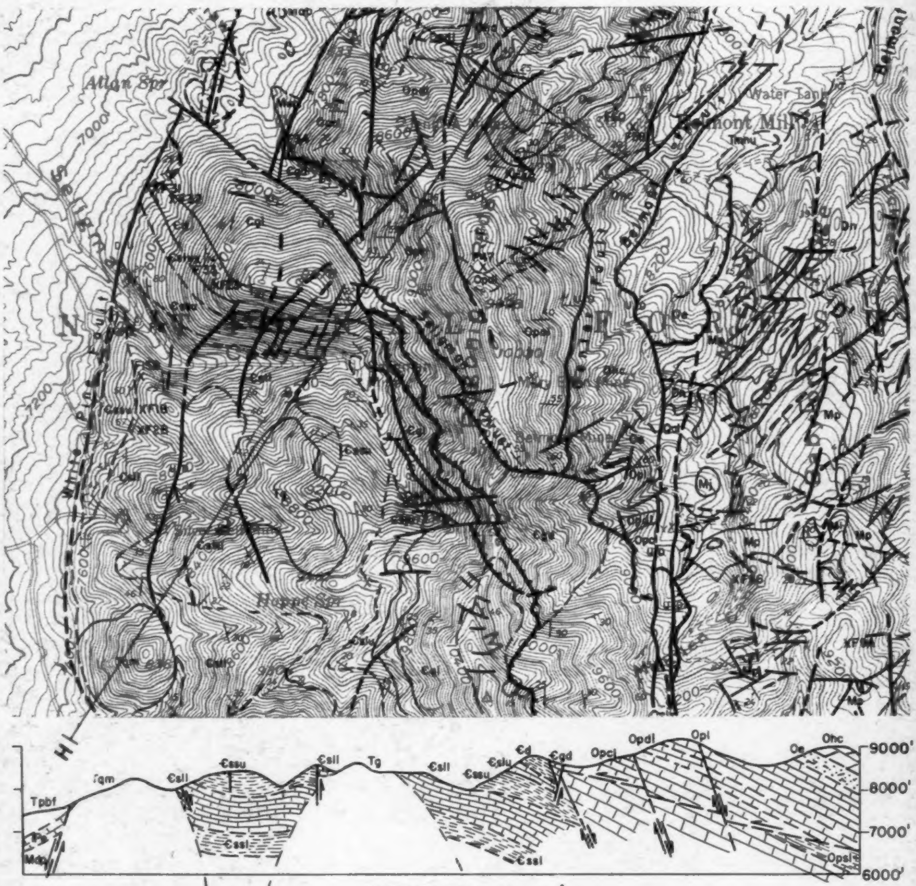

SECTION H - H'

We'll give you the following clues:

Scale - 1:48,000. Location — somewhere west of the Mississippi.

If you give up look on page 51